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FULTON (R. A.), SMITH (F. F.), LUNG (P. H.), YEOMANS (A. H.) & ROGERS (E. E.). **Particle Size and Toxicity of Aerosols affected by HETP Concentration.**—*Agric. Chem.* **4** no. 1 pp. 35–38, 67, 3 figs., 4 refs. Baltimore, Md., 1949.

HETP (hexaethyl tetraphosphate) in aerosols has been found to control many pests in greenhouses with little injury to the foliage of the plants [*cf. R.A.E.*, A **37** 469] except when applied at high temperatures [but *cf.* **37** 309] or in excessive amounts, when tomato, chrysanthemum, rose and carnation may be damaged. In some tests, equally good control with less plant injury was obtained with a given amount of aerosol when the concentration was halved [*cf.* **37** 469], and investigations were therefore made with several concentrations of HETP in methyl chloride to determine the effect of the concentration on the average particle size, pest control and plant injury. The tests were made against *Macrosiphum solani*, Kalt. (*Myzus convolvuli*, Kalt.), and adults of the two-spotted spider mite [*Tetranychus bimaculatus*, Harvey].

Preliminary tests in 1947 with aerosols of 1, 5 and 10 per cent. HETP containing 21 per cent. TEPP (tetraethyl pyrophosphate) in methyl chloride showed that 0·08 gm. HETP per 1,000 cu. ft. applied as a 1 per cent. aerosol was as effective as 0·1 gm. at 5 per cent. or 0·2 gm. at 10 per cent. It was subsequently found that the particle size of aerosols from solutions of 1, 5, 10 and 20 per cent. HETP (12·3 per cent. TEPP) decreased as the temperature rose and as the concentration decreased ; the 20 per cent. solution produced a much coarser aerosol than the others at 70 and 80°F., but at 90° and higher the particle size was similar to that produced by the 10 per cent. solution. Raising the temperature also increased the pressure of the methyl chloride, but the resulting increase in the rate of flow of the aerosol solution through the nozzle was not great enough to prevent the decrease in particle size. A comparison of aerosols from two solutions containing 20 per cent. HETP in methyl chloride, one of which was heated to 140°F., at which the pressure was 150 lb. per sq. in., while the other was subjected to the same pressure by means of carbon dioxide, was then made. There was no difference in particle size, indicating that pressure rather than heat was responsible for the decreased particle size. Raising the temperature of aerosol solutions containing 1 or 5 per cent. HETP (12·3 per cent. TEPP) from 70 to 120°F. had no effect on the kill of mites on beans or rose.

In a test to determine the duration of effectiveness of the particles released at temperatures between 75 and 80°F., infested plants exposed after the release of an aerosol containing 10 per cent. HETP (21 per cent. TEPP) at a rate to give 1 gm. HETP per 1,000 cu. ft. were removed at definite intervals and replaced by other infested plants. On the basis of the known falling rates of particles of different sizes and the measurements of particles collected on glass slides, only the particles under 20 microns in diameter remained in the air for more than four minutes and only those under 5 microns remained suspended after 15 minutes, and it was evident that HETP remained toxic to both the Aphid and the mite after the larger particles had settled out of the atmosphere. Toxicity was highest in the first 30 minutes, but continued into the second half-hour for the Aphid and into the second hour for the mite ; the more prolonged toxic action against the mite suggests that more than one component of the insecticide is responsible for the killing action. In additional tests with the same aerosol, the times required for high kills of the mite were variable, but high mortalities at the point of release were given by exposure for only two minutes in some tests and for ten minutes in all tests. At a distance of 40 ft., fairly high mortality was obtained in five minutes in one test. Young plants of a very susceptible variety of tomato that were exposed for the first

(558) Wt. P2701/3853 7/50 S.E.R. Ltd. Gp. 432. [A]

five minutes after release of the aerosol developed as many necrotic leaf spots as those exposed for the first 15 or 30 minutes and nearly as many as those exposed for an hour, whereas plants exposed for 55 minutes beginning five minutes after release were uninjured ; thus injury is correlated with the time required for the settling of the particles more than 20 microns in diameter.

The data presented show that there is a definite relation between the particle-size distribution of HETP aerosols and plant injury and pest control. Dilute solutions (1 and 5 per cent.), which produce smaller particles, are more toxic to pests per unit weight of dispersed insecticide than more concentrated ones and cause less plant injury. The average particle size of HETP aerosols can be reduced by using more dilute solutions, by heating to 120°F., or by increasing the pressure with carbon dioxide, but since the last two methods do not eliminate the larger particles responsible for plant injury, and since heating does not increase the toxicity and may involve a danger of explosion, it is considered that the use on susceptible plants of more dilute aerosols in amounts sufficient to obtain the dosage recommended for pest control is safer and more reliable than heating a more concentrated solution.

SWAN (D. C.) & BROWNING (T. O.). **The Black Field-cricket (*Gryllulus servillei* Saussure) in South Australia.**—*J. Dep. agric. S. Aust.* **52** no. 7 pp. 323–327, 1 fig., 11 refs. Adelaide, 1949.

A serious outbreak of *Gryllulus servillei*, Sauss., occurred in South Australia in 1947–48, when pastures on black swampy soils in parts of the south-east and in districts near Adelaide were severely damaged [*cf. R.A.E.*, A **25** 653]. All stages of this cricket are briefly described, and an account is given of its bionomics based on studies begun in 1948. It is indigenous in Australia, where it appears to be confined to the winter rainfall belt of New South Wales [*cf.* **28** 98], Victoria and South Australia. It is common in the wetter parts of South Australia, but forms swarms and is injurious only on black clay soils of the rendzina type that crack deeply as they dry out in summer ; these soils are frequent in the south-east of the State.

There is one generation a year. Eggs are laid in the soil within an inch of the surface during February–April ; in a pasture area of about four acres, they were found distributed at a density of up to 50 per square inch. They hatch in November, and the adults appear in January or February. In the laboratory, eggs that were kept moist withstood low temperatures and hatched normally at temperatures above 15°C. [59°F.] ; they were killed by prolonged exposure to drought. At 25°C. [77°F.], the egg stage occupied 13 days. Both nymphs and adults feed mainly on plants, but are cannibalistic in cages. They are active at night and usually shelter by day, preferably in crevices in the soil ; during outbreaks, however, the swarms sometimes travel or feed by day, and the crickets shelter under clods or objects lying on the ground and in tussocks of dead grass. Rendzina soils favour the development of swarms because they provide moisture for the dormant and developing eggs during winter and crevices in which the nymphs and adults shelter in summer, but become less suitable when these characters are destroyed by cultivation. Heavy infestations occurred only on permanent pasture and on crops adjoining grassland. In infested pastures, low plants are cut off at ground level, and tall ones remain standing as dead tufts. Damage to permanent pasture occurs in late summer and early autumn, when feed for grazing animals is scarce ; furthermore, the young shoots are destroyed as they appear after early autumn rains, as a result of which the plants sometimes die. The adverse effects may persist for over a year, and denuded areas become covered by undesirable winter-growing

annual weeds. Control measures that have proved effective against crickets elsewhere and would probably be so against *G. servillei* are reviewed from the literature.

Ossiannilsson (F.). **Äro gröna hagtornsbladloppan** (*Psylla peregrina* **Först.**) **och rönnbladloppan** (*Psylla sorbi* (**L.**) **Edw.**) **endast raser av äppelbladloppan** (*Psylla mali* **Schmidb.**) **?** [Are *Psylla peregrina* and *P. sorbi* merely Races of *P. mali ?*]—*Medd. Växtskyddsanst.* no. 51, 14 pp., 16 figs., 11 refs. Stockholm, 1948. (With a Summary in English.)

Some workers have considered that *Psylla sorbi*, L., on mountain ash (*Sorbus aucuparia*), *P. mali*, Schm., on apple and *P. peregrina*, Först., on hawthorn (*Crataegus*) are conspecific [*cf. R.A.E.*, A **6** 430 ; **9** 155 ; **23** 79, etc.]. The author compared examples from all three plants in Sweden, and describes morphological differences between them in the adults and fifth-instar nymphs. *P. sorbi* did not pair with either of the others, and he considers that the three are distinct species, each confined, except for accidental occurrences, to its own food-plant.

Kanervo (V.) & Talvitie (Y. K. K.). **Tutkimuksia sinappikuoriaiskärpäsestä,** *Meigenia mutabilis* **Fall.** [Studies on *M. mutabilis*.]—*Ann. zool. Soc. zool. bot. Vanamo* **11** no. 5, [5+] 45 pp., 4 figs., 63 refs. Helsinki, 1946. (With a Summary in German.)

The following is based on the authors' summary. The Chrysomelid, *Phaedon cochleariae*, F., is a common and destructive pest of cruciferous crops in Finland [*cf. R.A.E.*, A **20** 78], and investigations on the possibility of increasing the effectiveness of its natural enemies were carried out in 1932 and again in 1937–40. The most important of these was found to be the Tachinid, *Meigenia mutabilis*, Fall. (*floralis*, Fall.), which occurs throughout southern and central Finland and was locally extremely common. Its synonymy is discussed, and an account is given of observations on its bionomics and alternate hosts.

The adults were present from late May or early June to the end of September, and pairing took place in the laboratory 2–3 days after emergence. At 18–22°C. [64·4–71·6°F.], oviposition usually began 4–7 days after emergence, but was sometimes delayed for up to 26 days. The egg-laying period lasted 1–2 weeks, and older host larvae were preferred, the number of eggs laid on each ranging up to 18. Its hosts other than *P. cochleariae* were found to be *Lilioceris merdigera*, L., *Chrysomela varians*, Schaller, *Gastroidea polygoni*, L., *G. viridula*, Deg., *Melasoma aeneum*, L., *Phytodecta quinquepunctatus*, F., *P. viminalis*, L., and *Athalia rosae*, L. (*colibri*, Christ). Eggs were also laid on a few larvae of *Agelastica alni*, L., and *Chrysomela polita*, L. It was found that the size of the parasites, the duration of development, the life-span of the adults and the number of eggs per female varied directly with the size of the host. Females reared from *Phaedon cochleariae* laid 41–87 eggs, whereas those from *C. varians* laid 43–217. The females lived for 2–47 days and the males for 2–34, and on the average, the sexes were equally numerous. The egg stage lasted less than two days, and the larval stage was completed in 6–16 days at 21·5–16·7°C. [70·7–62·06°F.]. Pupation took place mostly in the host larva and sometimes in the pupa or outside the host. At 22–16°C. [71·6–60·8°F.], the pupal stage lasted 8–21 days. Development from egg to adult was completed in 18–19 days in *P. cochleariae*, 25–26 in *C. varians* and 24–31 in *Athalia rosae*.

The parasite population is limited by the fact that only one individual completes its development per host, and by high mortality during the egg and larval

stages ; in the laboratory, parasites were reared from only 47 per cent. of the hosts parasitised. The number of generations per year is seldom more than two, and sometimes only one, since favourable hosts are not always available. The preferred hosts include two important pests, *Phaedon cochleariae* and *Athalia rosae*, and as many as 70 and 80 per cent., respectively, of mature larvae of these species taken in the field were parasitised by *M. mutabilis*. It is concluded that the Tachinid shows promise for the biological control of *P. cochleariae*, since it produces two generations within the period required by the host to produce one, is easy to breed in numbers in the laboratory and can be reared on several different hosts.

BRAUN (H.) & RIEHM (E.). **Krankheiten und Schädlinge der landwirtschaftlichen und gärtnerischen Kulturpflanzen und ihre Bekämpfung.** [Diseases and Pests of Field and Garden Crops and their Control.]—6th edn. revd. by H. Braun, $9\frac{3}{4} \times 6\frac{3}{4}$ ins., vii+345 pp., 244 figs., many refs. Berlin, P. Parey, 1950. Price cloth 22 *DM.*, boards 20 *DM.*

The first part of this handbook on the pests and diseases of field crops, fruits and vegetables in Germany consists of a discussion of the general concept of plant disease, the various agencies that cause it, including insects and mites, predisposing factors, economic importance and the various kinds of protective measures. The main part is divided into sections each dealing with a single crop or group of crops. Emphasis is laid on the importance of correct diagnosis, and each of these sections opens with a key enabling the pest or disease concerned to be identified from the symptoms produced. Short accounts are given of the bionomics, appearance and control of the insects and mites, and in the case of virus diseases transmitted by insects, mention is made of the species responsible. There is a final section on polyphagous pests.

THIEM (H.). **Betrachtungen zur Lage und Bekämpfung der San José-Schildlaus im südwestdeutschen Befallsgebiet.** [Observations on the Status and Control of the San José Scale in the infested area in south-western Germany.]—*Z. PflKrankh.* **55** pt. 1–2 pp. 17–29, 1 map, 16 refs. Ludwigsburg, 1948.

The author gives an account of the discovery, spread and present distribution of the San José scale [*Quadraspidiotus perniciosus*, Comst.] in south-western Germany [*cf. R.A.E.*, A **38** 164, etc.] and states that it has now also been found in the south of Baden (near Rastatt), in two localities each in Württemberg and Franconia, and in the Saar near Homburg. It appears to have been spread from a large nursery at Speyer, where it was probably introduced on stock from Italy. The serious damage it has already caused to currant and apple, the most severely infested plants, is discussed, and it is shown that the mild climate of the fruit-growing district of the Bergstrasse is especially favourable to its development. It has two generations a year, the crawlers appearing between mid-June and mid-July and from mid-August to late autumn. The severity of the injury, as compared with that caused by other Coccids, is probably due to the injection of a toxic substance into the plant tissues during feeding, which produces physiological changes in the cells and checks growth. Once necrotic changes become established they are irreversible. In the absence of more effective insecticides, infested plants were sprayed with tar distillate (emulsified carbolineum [*cf.* **35** 70]) or dinitro-o-cresol in winter. Complete control was not obtained, but the condition of the treated trees was considerably improved.

Sy (M.). **Über die Bedeutung der zweiten Generation des Apfelwicklers** (*Cydia pomonella* **L.**) **und deren Bekämpfung.** [On the Significance of the second Generation of *C. pomonella* and its Control.]—*Z. PflKrankh.* **55** pt. 1–2 pp. 29–34, 4 figs., 4 refs. Ludwigsburg, 1948.

Although *Cydia pomonella*, L., had been shown to produce a second generation on apple in Germany during the summer [*cf. R.A.E.*, A **29** 71 ; **33** 119 ; etc.], the precise economic importance of that generation was not known. An experiment carried out near Bonn in 1947 is described, showing that it is greater than that of the first generation. Apple trees of several varieties were sprayed on 28th May and 3rd June, in accordance with moth emergence data, with 0·05 or 0·01 per cent. E 605 f [parathion with 30 per cent. emulsifier], 2 per cent. Gesarol (5 per cent. DDT) or 0·4 per cent. lead arsenate. Fallen fruits were examined twice weekly from 1st July, and the average numbers infested by 22nd July were reduced by 98·5, 96·8, 88·2 and 88·2 per cent. for the four sprays, respectively, as compared with no treatment. Conditions remained much the same, with no infestation recorded for E 605 f at 0·05 per cent., until 5th August, when infestation began to increase slightly. On 15th August, there was a sudden rise in infested dropped fruits from the untreated trees and a parallel increase for the treated ones, though that for lead arsenate was somewhat less steep. This increase was doubtless due to larvae of the second generation. The deposits from the organic insecticides had apparently lost their effectiveness by that time, while the lead arsenate still showed some toxicity, no doubt as a result of the exceptionally dry summer. The percentages of all fruits infested during the season were 13·4 and 13·5 for 0·05 and 0·01 per cent. E 605 f, 13·6 for DDT, about 8 for lead arsenate and 22·8 for no treatment. Since 0·05 per cent. E 605 f had permitted practically no infestation by the first generation, the 13·4 per cent. infestation at harvest was due to the second. The difference between this figure and the 22·8 per cent. infestation in the controls is taken as the infestation due to the first generation, and from comparison of the two figures thus obtained, it is concluded that 41 per cent. of the total infestation was due to the first generation and 59 per cent. to the second. These figures still minimise the importance of the second generation, since many of the fruits infested by the first would have dropped from other causes even if uninfested, while every fruit infested by the second represents a true loss.

The bearing of these observations on control is briefly discussed. There was no reason to consider the importance of the second generation in 1947 as exceptional, and the condition is thought to hold for the whole of western Germany. Lead arsenate cannot be applied against the second generation because of the residue problem, and it is not known how far it can be replaced by synthetic organic insecticides. When E 605 f at 0·05 per cent. was used against the first generation on the same dates in a neighbouring locality, where the climate differed somewhat, it gave no control, evidently because it was applied too early to maintain a toxic deposit, so that the prospects of prolonged action to combat the second generation is remote, and repeated applications are expensive. Before this problem can be solved, however, knowledge of local emergence dates is urgently required.

Trappmann (W.). **Arsenmittel im Pflanzenschutz—Rückblick und Ausblick.** [Arsenicals in Plant Protection—Retrospect and Prospect.]—*Z. PflKrankh.* **55** pt. 1–2 pp. 35–53, 122 refs. Ludwigsburg, 1948.

The author discusses the advantages and disadvantages of arsenicals for use in controlling insect pests of plants, attempts that have been made to improve them or replace them by other inorganic and naturally occurring organic

compounds and mechanical measures, and the recent development in various countries of synthetic organic compounds that are more effective than arsenicals.

STELLWAAG (F.). **Einige Ergebnisse der physiologischen Wertbestimmung neuer synthetischer Kontaktgifte.** [Some Results of the physiological Evaluation of new synthetic Contact-Poisons.]—*Z. PflKrankh.* **55** pt. 1–2 pp. 53–57. Ludwigsburg, 1948.

The author emphasises the importance of a knowledge of the " minimum lethal dose " in working with modern synthetic contact insecticides and indicates methods of ascertaining it by allowing test insects to run over deposits from a solution of known strength applied at different rates or from solutions of graded concentrations applied at one rate. In experiments with preparations of BHC (benzene hexachloride) or DDT, symptoms of poisoning appear in a definite sequence of five phases, comprising a brief phase of excitement, disorder in locomotion, lying on the back with excited movement of the legs, complete inactivity, except for some response to stimulation, and death. The sequence is rapid if the dosage is high, but is sometimes so slow at low dosages that it is difficult to determine when death occurs. It was therefore desirable to know whether insects can recover once the sequence has begun, since if not, an experiment need not be continued until death. Experiments in which adults of *Calandra granaria*, L., were exposed to Gesarol (5 per cent. DDT) at various concentrations or earwigs (*Forficula* [*auricularia*, L.]) were immersed for one minute in suspensions of Gesarol or BHC indicated that concentrations high enough to cause the insects to lie on their backs also cause their death, but that lower concentrations may cause disorder in locomotion from which the insects recover. Experiments can therefore be discontinued at the onset of the inactive phase.

In the course of tests with numerous insecticides against *Leptinotarsa decemlineata*, Say, it was found that the minimum lethal doses were 0·01–0·05 per cent. for BHC (mixed isomers) and 0·1, 0·5 and 0·0005 per cent. for α, β and γ BHC, respectively. The mixture of isomers was ten times as toxic as DDT. In tests of solubility in water, a 5 per cent. suspension of a powder containing 2 per cent. total BHC was filtered after standing for an hour, and larvae and pupae of *Culex pipiens*, L., were placed in the filtrate. The larvae sank but quickly returned to the surface, while the pupae remained at the surface. The larvae became restless in ten minutes and again sank to the bottom, where they soon entered the inactive phase ; the pupae sank after about 30 minutes, and lay on their sides some 20 minutes later. In a similar test with larvae alone, symptoms of poisoning appeared in six minutes and inactivity in eight. Fumigant effects were tested by enclosing adults of *L. decemlineata* and *Cantharis fusca*, L., with total BHC and the pure γ isomer in covered dishes in such a way that contact was prevented. *Leptinotarsa* showed no symptoms even after several days, but *Cantharis* became restless after 30 minutes with γ BHC and after 60 minutes with the mixed isomers, inactivity following in 5 and 6–7 hours. Dusts containing 5 per cent. mixed isomers or γ isomer diluted with talc were also tested, but had no effects. It appears, therefore, that no fumigant action can be expected in the open air, though it might occur in the soil or between closely adhering plant parts.

The effect of weathering was studied by dusting leaves at noon in sunny weather, removing them after 48 hours during which there was no rain or dew, and placing test insects on them under glass covers. A mixture of α, β and γ isomers applied as a 2 per cent. dust in talc at a rate initially toxic to *Calandra granaria* killed *Forficula*, but did not affect the weevil. Since tests had shown that the minimum lethal concentrations were 0·001 per cent. for the weevil and

0·0005 per cent. for the earwig, the concentration of toxicant had fallen from about 2 per cent. to between these two figures. In a similar experiment with a 1 per cent. dust, the content of active compound was reduced to 0·0008 per cent. It is essential, therefore, that the proportion of BHC in a mixed dust should not be too low.

HENNIG (W.). **Die Larvenformen der Dipteren. Eine Übersicht über die bisher bekannten Jugendstadien der zweiflügeligen Insekten. 1. Teil.** [Larval Forms in Diptera. A Review of the known immature Stages of Dipterous Insects. Part 1.]—[3+]184[+1]pp., 3 pls., 70 figs., refs. Berlin, Akademie-Verlag, 1948. Price *DM* 22. **2. Teil.** [Part 2.]—vii+458 pp., 10 pls., 236 figs., refs. 1950. Price *DM* 49.

These are the first two parts of a work on the morphology of the larvae and pupae of the Diptera, which is to consist in all of three parts. In the system of classification adopted by the author, the Diptera are divided into two suborders, Nematocera and Brachycera. These two parts deal with the Nematocera, the first with the Bibiomorpha and the second with the Culicomorpha. The morphology of Dipterous larvae and pupae and the significance of larval and pupal characters for phylogenetic classification are discussed in an introductory section. The main part of the book consists of lists of the families, with accounts of their phylogenetic status, the characters of the larvae and pupae, and their subdivisions and geographical distribution, followed by keys to the genera and lists of species, with references to published descriptions of the larvae or pupae and indications of any parts figured in them.

RAINEY (R. C.) & WALOFF (Z.). **Desert Locust Migrations and synoptic Meteorology in the Gulf of Aden Area.**—*J. Anim. Ecol.* **17** no. 2 pp. 101–112, 6 figs., 9 refs. London, 1948.

The following is virtually the authors' summary. The meteorological data relating to a number of swarm movements of *Schistocerca gregaria*, Forsk., recorded in the Gulf of Aden between 1941 and 1947 have been examined, using the corresponding synoptic charts. The trajectory of the air in which a flying swarm is observed, considered in relation to recent determinations of the air-speed of *Schistocerca* (about 11 miles per hour), is shown to provide evidence of the origin and destination of the swarm, affording in favourable circumstances a good indication of its probable track, and making possible some deductions as to the course or orientation of the locusts. Trajectories relating to swarms arriving on the coast of British Somaliland during the winter indicate the migration of swarms of the monsoon generation across the Gulf of Aden from the Hadhramaut. Records of swarms reaching Aden and the adjacent coast in summer give trajectories indicating the migration of swarms of the long-rains generation from western British Somaliland, also across the Gulf. It appears probable that locusts of phases *transiens* and *solitaria* may similarly migrate across the Gulf. Swarms landing on the coasts of the Somali peninsula during the summer are shown to be probably mainly of local origin, swept out to sea by the monsoon and subsequently brought in again by the sea-breeze. An alternative possibility in some of these cases is that of transportation across the Gulf by the north-easterlies that overlie the south-west monsoon and are probably continuous with the surface north-westerlies of Arabia at this season. Evidence of the significance of convection currents in relation to flying locusts is provided by the frequent association of swarm movements with rising sand, dust-storms and similar manifestations of intense convective activity near the ground, and by an aircraft report of locusts at 7,000 ft. at an air temperature indicating unimpaired convection currents from the surface to at least this height.

Salt (G.), Hollick (F. S. J.), Raw (F.) & Brian (M. V.). **The Arthropod Population of Pasture Soil.**—*J. Anim. Ecol.* **17** no. 2 pp. 139–150, 1 fig., 16 refs. London, 1948.

The following is virtually the authors' summary. From 20 samples of soil, each 4 ins. in diameter and 12 ins. deep, collected on 26th November 1943 from a pasture near Cambridge, there were extracted 42,753 Arthropods, representing a population of 268·6 thousand per sq. metre, or 1,068·8 million per acre. The collection is known to be incomplete, chiefly by loss of small Acarina, and it is estimated that the complete Arthropod population was at least 1,400 million per acre. The numbers belonging to the principal Arthropod groups that were collected and the populations they represent are shown in a table.

Davidson (J.) & Andrewartha (H. G.). **Annual Trends in a natural Population of *Thrips imaginis* (Thysanoptera).**—*J. Anim. Ecol.* **17** no. 2 pp. 193–199, 5 figs., 11 refs. London, 1948.

The following is largely based on the authors' summary. In connection with investigations on the bionomics of the apple blossom thrips, *Thrips imaginis*, Bagn., in Australia [*R.A.E.*, A **23** 506, 726 ; **24** 135, etc.], the numbers of adults in roses in the garden at the Waite Institute, South Australia, were collected by a method already noticed [**21** 625] on 1,773 days during 1932–38, giving a continuous record for the density of the population during 81 successive months. The total variability of the daily records may be considered to have three components due, respectively, to the natural growth of the population, the influence of the weather about the time the sample was taken on the activity of the thrips in seeking out flowers, and the influence of the weather throughout the year on the rate of multiplication of the insects [see next abstract]. Spring is the only season when the influences of temperature, moisture and food are likely to be most favourable for *T. imaginis*, which can increase earlier and more quickly when food is plentiful in early spring. Flowers are generally more plentiful on the food-plants in years when the blossoming period starts early, and this in turn generally occurs in years when the wet season begins early in the preceding autumn and permits the plants to make adequate growth before winter. The same trend of population tends to be repeated each year. Numbers usually reached a minimum during August, increased rapidly during September–November, declined during December–January, and remained low for the rest of the year except, in some years, for a small increase during May–June. A logistic equation is given, relating the number of thrips per rose with the date, by which the average trend of population during September and November is represented.

Davidson (J.) & Andrewartha (H. G.). **The Influence of Rainfall, Evaporation and atmospheric Temperature on Fluctuations in the Size of a natural Population of *Thrips imaginis* (Thysanoptera).**—*J. Anim. Ecol.* **17** no. 2 pp. 200–222, 5 figs., 24 refs. London, 1948.

The following is largely based on the authors' summary. Counts of the numbers of *Thrips imaginis*, Bagn., in roses at the Waite Institute, were made almost daily during September–December for 14 years between 1932 and 1946 [*cf.* preceding abstract]. The roses were highly attractive to the adults, but were not favourable for the development of immature stages. They served as a trap that gave a satisfactory indication of the density of the population in the area. The method of partial regression was used to measure the degree of association between the numbers of thrips present during the spring and the weather experienced during the preceding months. With the aid of precise

knowledge of the biology of *T. imaginis* [*R.A.E.*, A **23** 506, 726 ; **24** 135, etc.] and the weather of the Adelaide area, it was possible to select four components of the physical environment likely to be closely associated with the density of the spring population. The analysis showed that 78 per cent. of the variance of the population could be related to these four quantities. They were, in order of decreasing importance, the sum of effective temperatures between the date when the break of the dry season in autumn allows the seeds of the annual food-plants to germinate and the end of winter (31st August), the amount of rainfall during September–October, which, besides affecting the pupae directly through soil moisture, also exerts an indirect and probably less important effect through the food-plants, the temperature during the autumn and winter of the preceding year, which probably influences the food-plant, and the temperature during September–October. Since pollen is required for growth and reproduction in *T. imaginis* and since mortality among the pupae may be high when soil moisture is inadequate, the favourable period for multiplication begins when pollen becomes available in spring and ends with the onset of the dry season. The maximum density attained by the population in spring is thus largely determined by the weather during the preceding autumn, but rainfall and, to a less extent, temperature during early spring may modify the tendencies established then. Competition plays little or no part, since, although the insects increase rapidly during the favourable period, the number of situations available to them increases also, and the favourable period normally ends long before they have saturated their environment. The onset of the summer drought brings about a sudden heavy drop in numbers, which decline to the low level characteristic of late summer and winter. The annual fluctuations in maximum density are controlled almost entirely by density-independent components of the environment. During the period each year when the population is decreasing, weather continues to be the most important influence determining its density, and no evidence was obtained of any predators, parasites or diseases of importance. The population never completely dies out, since during the period when it is decreasing, weather operates as a density-dependent component of the environment, and the thrips becomes restricted to local situations more favourable than the surrounding countryside, from which it again spreads when conditions become suitable.

It was also found that the movement of the thrips into the flowers is influenced by the daily weather. The movement was greater during warm, dry days and less during cold, wet ones, temperature being a more important factor than humidity.

NUTMAN (F. J.) & SHEFFIELD (F. M. L.). **Studies of the Clove Tree. I. Sudden-death Disease and its Epidemiology.**—*Ann. appl. Biol.* **36** no. 4 pp. 419–439, 2 pls., 8 figs., 5 refs. London, 1949.

Sudden-death disease of clove trees, which also occurs in Madagascar, has been steadily increasing in both Zanzibar and Pemba for many years. The only premonitory symptom is a slight chlorosis followed by thinning of the foliage and reduction of the absorbing system. Death follows after a period, which may vary from only a few days to many months, as a result of lack of water caused by the disorganisation of the absorbing roots. The outbreaks fall into three classes : the sporadic, which ceases to spread after killing a few trees ; the " Pemba " type showing clear peripheral spread ; and the diffuse epidemic type. In Pemba, some 500 small outbreaks are scattered through the clove areas and some seem to be passing from the second type to the third. The total number of trees affected there is less than in Zanzibar, where the situation approximates to a single outbreak involving half the clove-growing area of the island. The rate of spread of the disease varies, but it is accelerating.

Various causes, physical, physiological, and pathological, have been suggested to account for the condition. The epidemiology suggests that all but a pathogenic hypothesis can be discarded. Of the possible pathogens, a virus carried by a lethargic vector is the most probable. Suspicion is attached to a Coccid that is associated with the tree-nesting ant, *Oecophylla longinoda*, Latr. var. *textor*, Santschi ; it is stated in a footnote that W. J. Hall, who visited the Protectorate in 1949 and found several Coccids on clove, agreed that only one could be regarded as a possible vector. This he considered to be a probably undescribed species of *Saissetia*. The ant is widespread and very abundant on clove trees in Zanzibar, but in Pemba it is numerous only locally ; the ants on any one tree or group of trees of which the branches are in contact form a single community. Colonies of the Coccid are established within the nests and on the young terminal twigs, especially the inflorescences. In the latter situations, they are invested by silken shelters, which probably afford them some protection from parasites. These comprise at least two species (thought to be undescribed species of *Encyrtus* and *Coccophagus*). The ants leave trees that die from any cause, taking the Coccids with them, and found new colonies on mature clove trees or, if these are not available, on young clove or a variety of other plants, at distances sometimes of hundreds of yards. The ant and the Coccid were always found in association, and sudden death was never found in their absence. The view that the Coccid is the vector of the disease is supported by the voracious nature of the ant, which would render survival difficult for any sucking insect not protected by it. The rapid spread of the disease in closed canopies and the slower spread where the canopy is opened or the trees are small and isolated, the relative freedom of young trees, the fact that some old trees may temporarily escape infection, and the marked difference in epidemiology in the two islands are also explicable on this theory.

Oecophylla is attacked by an exotic terrestrial ant, *Anoplolepis longipes*, Jerd., in some parts of Zanzibar. Trees in a plantation known to have been freed from *Oecophylla* by it at least twelve months previously and apparently free from the Coccid continued to succumb to sudden-death, so that, if the Coccid is the vector, at least twelve months may elapse between infection and death.

Gregory (P. H.) & Read (D. R.). **The spatial Distribution of Insect-borne Plant-virus Diseases.**—*Ann. appl. Biol.* **36** no. 4 pp. 475–482, 14 refs. London, 1949.

The following is the authors' summary. Various workers have proposed formulae to express the spatial distribution of insect-borne diseases. All the published data examined, as well as the Rothamsted data for the spread of rugose mosaic and leaf-roll from point sources in potato crops [*R.A.E.*, A **37** 366], were fitted as well by the simple empirical expression $\log I = a + bx$ as by more complex expressions (I=number of infective punctures at a distance x from the source after a given time, and a and b are constants for any one given set of field conditions). It is suggested that distances should always be given in metres, in order to give comparable results from one investigation to another. In the analysis of data on rugose mosaic and leaf-roll in different years, it is shown that a and b vary independently.

Broadbent (L.), Cornford (C. E.), Hull (R.) & Tinsley (T. W.). **Overwintering of Aphids, especially** *Myzus persicae* **(Sulzer), in Root Clamps.**—*Ann. appl. Biol.* **36** no. 4 pp. 513–524, 3 figs., 4 refs. London, 1949.

The following is partly the authors' summary. Mangel clamps in many districts of Britain were found in 1946–48 to provide overwintering sites for

Myzus persicae, Sulz., *Rhopalosiphoninus* (*Hyperomyzus*) *staphyleae*, Koch, and *Macrosiphum* (*Aulacorthum*) *solani*, Kalt. After a severe winter, when other means of overwintering are few, clamps may be the most important source of *Myzus persicae*. Only *Myzus ascalonicus*, Doncaster, was found in swede clamps.

Factors affecting the infestation of clamped mangels by *M. persicae* were the number of Aphids on the crop when lifted, the methods of topping and clamping the roots, and the temperature in the clamp. *M. persicae* was introduced on the leaves, and close topping was often an efficient means of control. Close topping did not control *R. staphyleae* ; normally this Aphid does not seem to be a root-feeding species, but with mangels growing in pots it fed on both exposed roots and foliage. It is not known how this species enters the clamps. The temperature in clamps was higher than that of the surrounding air, and though it was influenced by it, the changes were long-term ones and did not reflect diurnal variations. It was also influenced by the type of cover ; straw covered with soil gave the best protection from frost. Aphid populations usually increase to a peak in early spring and then decline rapidly owing to the migration of the alates or the activities of parasites and predators. Aphid numbers may increase again later, especially on mangel shoots growing through the cover of the clamp in summer.

Observations on sugar-beet growing in fields and in pots placed near clamps showed that the latter are important sources of infection with sugar-beet yellows transmitted by *M. persicae*. There is a tendency to sow root crops and set potatoes earlier than in former years, so that the period during which they are exposed to attack by Aphids from mangel clamps is extended. Where mangels are not required after early April, the Aphids can be controlled by clearing the clamp site, but if they are needed as stock-feed until the summer, special measures against the Aphids are desirable, though their use would increase the cost of producing mangels. Dusting with 3 per cent. derris or nicotine during clamping at a rate of 1 lb. per ton of mangels was of no value, and alates of *M. persicae* swarmed in large numbers out of a clamp that was covered with loose straw into which benzene-hexachloride dust was blown in early June, but nicotine vapour injected into clamps through perforated tubes attached to a nicotine fumigation machine [*R.A.E.*, A **34** 370] gave some control in June 1947.

DUNN (E.). **Colorado Beetle in the Channel Islands, 1947 and 1948.**—*Ann. appl. Biol.* **36** no. 4 pp. 525–534, 5 figs., 9 refs. London, 1949.

During 1947, 389 living adults of *Leptinotarsa decemlineata*, Say, were found in Jersey [*cf. R.A.E.*, A **36** 259] between 28th May and 4th June, most of them along the eastern border of the island within 1–1½ miles of the coast, and 249 were observed during the rest of the summer. Large numbers of dead beetles, reaching at one place an estimated total of 15,000–20,000, were found on 6th June on the beaches, especially in the east and south, where they had evidently been washed up not later than 4th June. Only five living beetles were found in Guernsey and 34 in Sark, but on 9th June, large numbers of dead ones were found well above the tide mark on the beaches of both islands and also on Herm. A generation was completed on potato in Jersey, adults appearing at the end of July.

In tests, the beetles survived for up to ten days in sea water and some that survived for six days began to fly when the temperature reached 80°F. Beetles that had ceased ovipositing and had lost the protective layer of oil that covers them when they have recently emerged from hibernation survived for only 1–2 days and rarely flew. The maximum period of sustained flight in the laboratory was 13·75 minutes, and as they have been shown to fly at a speed of nearly 5 miles per hour the average flight range would be about a mile.

These findings, and the distribution of the beetles in Jersey, indicated that they had been carried to the islands by sea, a theory that was supported by reports of swarms flying over and dropping into the sea between the Cherbourg peninsula and Jersey and of large masses of floating beetles about five miles north of Jersey. The tidal flow round the islands would permit any beetles that alighted on the sea within 7–8 miles of the coast to be washed ashore on any of the beaches within a few days. *L. decemlineata* has been present on the Cherbourg peninsula since 1938 and occurred in unusually large numbers in the Carteret-Barnaville district, to the east of Jersey, at the end of May 1947. It is known to fly in swarms in spring and autumn when temperatures are high. Shade temperatures at the end of May and the beginning of June were 70–80°F. in France and 65–76°F. in Jersey, and warm air currents were flowing over Jersey from the east on 27th–28th May ; these weather conditions are exceptional at that season and occur only about once in ten years.

In 1948, one beetle was found on seaweed in north-eastern Jersey on 16th May and there were thousands, mostly alive, on seaweed along the high-water mark on the eastern beaches on 18th May. Weather conditions were almost identical with those prevailing at the end of May in 1947, but the temperature dropped on 18th May and the beetles were temporarily prevented from flying. Spring tides probably destroyed many. Experience gained during attempts to control the beetles by means of insecticides indicated that the use of hand-dusting equipment is too slow and that many beaches are too inaccessible to be sprayed satisfactorily, but few, if any beetles, reached the potato crop.

It is suggested that beaches facing the continent should be searched when shade temperatures in May or June exceed 70°F., and any beetles found there killed before they begin to fly ; spraying from the air appears to be the only measure likely to prove successful.

McIntosh (A. H.). **Relation between Particle Size and Shape of insecticidal Suspensions and their Contact Toxicity. II. D.D.T. and Rotenone Suspensions against** *Oryzaephilus surinamensis* **L., with some Time-mortality Studies.**— *Ann. appl. Biol.* **36** no. 4 pp. 535–550, 1 pl., 4 graphs, 24 refs. London, 1949.

The following is virtually the author's summary. Methods already worked out for the preparation and testing of aqueous DDT suspensions against *Tribolium castaneum*, Hbst., by a dipping method [*R.A.E.*, A **37** 263, etc.] were applied to *Oryzaephilus surinamensis*, L., and gave similar results, toxicity increasing with increase in particle size. In the same way, the precipitation of rotenone by exchange of solvents leads to the formation of simple aqueous suspensions. The theory of precipitation is described, and methods are given of preparing five types of suspension : colloidal rotenone, a suspension of small elongated plates, a suspension containing small hexagonal plates in aggregates, and two suspensions containing hexagonal plate-shaped crystals of different sizes. These were tested, by dipping, against *O. surinamensis*. Within the range of crystal sizes up to 150 μ, toxicity is inversely related to the size of particle in suspension. The variation in median lethal concentration obtained in this way is of the order of 600 times. Crystal shape seems to be unimportant. Similar results were obtained with fine suspensions, using a spraying method [**29** 591]. The variation of mortality with time was also studied, using DDT against *T. castaneum* and rotenone against *O. surinamensis*. In the former case, both colloidal and crystalline DDT showed progressively increasing kills with the passage of time. Crystalline rotenone behaved similarly, but colloidal rotenone gave an initial paralytic effect, followed by recovery of the insects.

Tobias (J. M.) & Kollros (J. J.). **Loci of Action of DDT in the Cockroach** (*Periplaneta americana*).—*Biol. Bull.* **91** no. 3 pp. 247–255, 1 fig., 11 refs. Lancaster, Pa., 1946.

The following are the authors' conclusions. Neither decapitation, section of one or several nerve cord connectives nor complete transection of the entire insect body at one or several levels between nerve cord ganglia prevents the development of the typical motor effects of DDT in any of the legs of the cockroach [*Periplaneta americana*, L.]. After combined antero-posterior isolation of a nerve cord ganglion, even median sagittal section of the ganglion does not prevent motor symptoms in the legs still attached to the lateral ganglionic cell masses. Therefore, the anatomical elements necessary for development of the motor symptoms of DDT are contained within the lateral half of a body segment which contains the lateral half of a ganglion, leg nerves and peripheral structures. Since the motor symptoms of DDT poisoning can occur in amputated legs, in legs whose nerves have been cut, and in legs whose segmental ganglia have been destroyed, it is possible for DDT to produce its motor effects by action on some structure or structures peripheral to the segmental ganglion. The motor symptoms of DDT poisoning can be stopped or diminished in a leg by ganglionectomy, leg nerve section, or ganglion synaptic block with nicotine. The effectiveness of these procedures is in inverse relation to the dose of DDT administered. These findings suggest that, in the cockroach, low doses of DDT may excite motor fibres reflexly by impulses fired into the ganglion over afferent nerve fibres, whereas high doses may act on elements on the motor side of the ganglion and thus not require an intact reflex arc. Since ganglionectomy stops the fast component of the hypermotor activity, however, equally well after large or small doses of DDT, this component may be reflexly initiated and maintained after all doses of DDT.

Tobias (J. M.), Kollros (J. J.) & Savit (J.). **Acetylcholine and related Substances in the Cockroach, Fly and Crayfish and the Effect of DDT.**—*J. cell. comp. Physiol.* **28** no. 2 pp. 159–182, 28 refs. Philadelphia, Pa., 1946.

The following are virtually the authors' conclusions. The thoracic portion of the ventral nerve cord of the cockroach (*Periplaneta americana*, L.) normally contains about 33 mmg. free and 12 mmg. bound acetylcholine per gm., and that of crayfish (*Cambarus* spp.) about 28 mmg. free ester per gm. ; the whole body of the fly (*Musca domestica*, L.), contains about 47 mmg. free ester per gm., almost all in the head and thorax. During the late prostrate phase of DDT poisoning, but not during the early hyperactive phase, the free acetylcholine content of the central nervous systems of the two insects rises about 200 per cent. The central nervous system of the crayfish shows a much smaller rise, and the free and total acetylcholine contents of the brains of rats and frogs and the submaxillary gland of rats are not changed. In the nerve cords of normal cockroaches and crayfish, the acetylcholine concentration is some 70 per cent. higher in the ganglia (58 and 36 mmg. per gm., respectively) than in the connectives (34 and 21 mmg.) ; during prostration after poisoning with DDT, practically all the rise in ester concentration is in the connectives in cockroaches, and there is a similar, but less obvious, change in the crayfish. The esterase activity of the nerve cord of normal cockroaches is about 1·7 times as great for acetyl-β-methylcholine as for acetylcholine, and is in neither case affected by poisoning with DDT [*cf. R.A.E.*, A **37** 331]. In the media used, the homogenised nerve cords of four or five cockroaches synthesised 2·7 times as much acetylcholine aerobically with a substrate comprising both lactate and glucose as with one of lactate alone. Anaerobically, synthesis of

47 mmg. per gm. was attained in 30 minutes. Nerve cords poisoned with DDT did not synthesise acetylcholine any faster than normal ones.

Complete deprivation of food and water for three days, or prostration caused by carbon dioxide, insulin or injected nicotine caused no increase in nerve-cord acetylcholine. Eserine and barbital increased it, but both showed anticholinesterase activity. Increases were also produced by cyclopropane or γ benzene hexachloride.

Cockroaches tolerate very large doses of carbaminoylcholine, acetylcholine or acetyl-β-methylcholine injected intra-abdominally, and the tolerated doses fall in the same order as the nerve-cord esterase activities for the esters. Nicotine, eserine or atropine applied to a nerve-cord ganglion produce a short-lived burst of great hyperactivity and subsequent complete quiescence in the segmental legs. Each of them, locally applied, finally produces quiescence, even though there be pre-existent DDT hyperactivity. This emphasises the importance of the ganglionic synapses in the hypermotor effects of DDT.

The active substance in the nerve cord of cockroaches and crayfish that increases after poisoning with DDT satisfied those tests for acetylcholine to which it was subjected. The water content of the nerve cord of normal cockroaches is 73·9 per cent. and that of cockroaches prostrate after poisoning with DDT 75·3 per cent. The increase in acetylcholine is therefore in no part a simple concentration effect due to dehydration. Bound ester is markedly decreased or entirely absent with a concomitant increase in the free fraction, when the acetylcholine level of the nerve cord is raised.

VINCENT (D.) & TRUHAUT (R.). **Contribution à l'étude du mécanisme de l'action physiologique de l'insecticide D.D.T. D.D.T. et cholinestérase du sérum.**—*C. R. Soc. Biol.* **141** no. 1–2 pp. 65–66, 5 refs. Paris, 1947.

Experiments are described in which DDT was shown to have no marked effect on the enzymatic hydrolysis of acetylcholine in horse serum to which it was added *in vitro* or in the serum of guineapigs into which a solution in olive oil was injected subcutaneously. Its effect on the cholinesterase of the nervous and muscular systems, which is known to differ from that of serum, was not investigated. If, as has been suggested, DDT proves to inhibit cholinesterase activity in insects [but *cf.* preceding abstract], this difference might account for the difference in the susceptibilities of mammals and insects to its toxic effects.

GRANGER (M. M.) & LEIBY (R. W.). **How Plants absorb Parathion.**—*Agric. Chem.* **4** no. 2 pp. 34–35, 79–81, 83, 85, 4 graphs, 1 ref. New York, N.Y., 1949.

The following is almost entirely based on the authors' summary of this account of greenhouse investigations in which it was shown that parathion, introduced into the soil in the form of a 15 per cent. wettable powder at, or in one test, before, the time of planting, is translocated in nasturtium, bean and squash plants grown from seed and in potato plants grown from tubers, and that the translocation is sufficient to cause mortality of insects placed on the growing plants. Complete mortality of *Aphis fabae*, Scop. (*rumicis*, auct.) on nasturtium seedlings was given for a period of seven weeks by 2 gm. powder mixed with 500 gm. soil, and smaller amounts produced lower kills. The same dosage gave 100 per cent. kill of third-instar larvae of *Epilachna varivestis*, Muls., on bean from the second to the third week after sowing, but did not appear to be effective against *Tetranychus bimaculatus*, Harvey, on the bean plant. When potato tubers were planted in 500 gm. soil containing 2 gm. powder, 100 per cent. kills of *Macrosiphum solanifolii*, Ashm., were given from

the third to the eighth weeks on the lower and older compound leaves ; the mortality was nearly as high when 1 gm. per 500 gm. soil was used. On the new growth of terminals of the same plants, the maximum kill was 10 per cent. or less, and it extended over a period of about seven weeks. On squash plants grown in soil containing 2 gm. powder per 500 gm., complete mortality of *Aphis gossypii*, Glov., was obtained only eight weeks after sowing. The kill from lower dosages was relatively low as compared with that of other insects on other plants, and there was no mortality when 0·25 gm. per 500 gm. soil was used. When 3 gm. powder per 500 gm. soil was added 3, 7 and 10 days before nasturtiums were sown, it apparently lost little of its toxicity, since it gave very high kills of *A. fabae* placed on the foliage. Retardation of early plant growth was evident in nearly all tests, but at the end of 8–11 weeks the plants grown in treated soil almost equalled others in size.

Burgess (A. F.) & Sweetman (H. L.). **The residual Property of DDT as influenced by Temperature and Moisture.**—*J. econ. Ent.* **42** no. 3 pp. 420–423, 1 graph, 9 refs. Menasha, Wis., 1949.

Experiments made in continuation of tests in a basement laboratory on the effect of temperature and humidity on the toxicity of DDT deposits [*R.A.E.*, A **36** 378], and noticed more fully elsewhere [B **38** 97] showed that the toxicity of the deposits to house-flies (*Musca domestica*, L.) over a period of three years decreased much more rapidly at high temperatures (37°C. [98·6°F.]) than at low ones when humidity was high. Both high temperature (37°C.) and high moisture (60–75 per cent. relative humidity) produced a more rapid reduction in toxicity of DDT than low temperature (23°C. [73·4°F.]) and low moisture (25–40 per cent. relative humidity).

Gaines (J. C.) & Dean (H. A.). **Effect of Temperature and Humidity on the Toxicity of certain Insecticides.**—*J. econ. Ent.* **42** no. 3 pp. 429–433, 4 graphs, 10 refs. Menasha, Wis., 1949.

Cage tests were carried out in Texas to determine the effect of temperature and humidity on the toxicity of several insecticides to *Anthonomus grandis*, Boh., on cotton plants. The median lethal rates of application in lb. per acre of 20 per cent. toxaphene in sulphur, calcium arsenate, 3 per cent. BHC (benzene hexachloride) with 5 per cent. DDT in sulphur, and 10 per cent. chlordan in sulphur were 1·9, 2·2, 2·2 and 2·8 in a laboratory test with laboratory-reared adults, during which the average daily temperatures ranged from 84 to 92°F. and the average daily relative humidities from 44 to 63 per cent. ; 4·4, 5·4, 8·6 and 18 in a laboratory test with field-collected adults at average daily temperatures and humidities of 78–93°F. and 34–70 per cent. ; and 3·9, 2, 7·5 and 23·1 in a greenhouse test with field-collected weevils at average daily temperatures and humidities of 76–108°F. and 27–87 per cent. In a field test with laboratory reared weevils at average daily temperatures and humidities of 73–107°F. and 24–90 per cent., the median lethal rates per acre for the toxaphene and calcium-arsenate dusts and the mixture were 3·7, 2·5 and 9·1 lb., and 10 per cent. chlordan gave only 36 per cent. mortality at rates of 6–12 lb. The toxicity of both 10 per cent. chlordan and 20 per cent. toxaphene was reduced when the weevils were not released on the plants until 24 hours after dusting, and the toxicity of toxaphene was also reduced by exposure to wind or sun. In tests carried out with calcium arsenate, 20 per cent. toxaphene in sulphur and 20 per cent. chlordan in sulphur at a constant temperature of 85°F. and relative humidities of 80, 70 and 45 per cent., the toxicity of all materials was affected by the humidity, being 2–4 times as high at 45 per cent. as at 80 per cent.

It is concluded that temperature and humidity affected calcium arsenate less than the organic compounds and toxaphene less than the other organic compounds, though the toxicity of both calcium arsenate and toxaphene was reduced by high temperature or high humidity, and that laboratory-reared weevils were considerably more susceptible than field-collected ones to the organic insecticides.

LAUDANI (H.) & MARZKE (F. O.). **Toxicity to Fabric Insects and Resistance to Washing and Dry Cleaning of Six Chlorinated Hydrocarbon Insecticides.**—*J. econ. Ent.* **42** no. 3 pp. 434–436. Menasha, Wis., 1949.

The results are given of laboratory tests, in which samples of woollen cloth were impregnated with organic insecticides at rates of 0·5, 1, 1·5, 2 or 3 per cent. of the weight of the cloth, thoroughly aired for seven days to remove all volatile constituents, and exposed to larvae of *Attagenus piceus*, Ol., for 28 days with no further treatment or after being washed or dry cleaned one, two or three times.

On cloth that had not been washed or dry-cleaned, chlordan, BHC (benzene hexachloride containing 6 per cent. γ isomer) and toxaphene gave 75–100, 0–100 and 25–52 per cent. kill and DDT, DDD (dichlordiphenyldichlorethane) and methoxy-DDT (methoxychlor) 15–47, 3–14 and 1–6 per cent., but DDT and DDD gave complete protection from visible damage (nap and warp feeding), chlordan and methoxy-DDT permitted a little at 0·5 per cent. and toxaphene a little at all rates, and cloth treated with BHC had scattered light nap and warp damage. With a few exceptions visible damage was directly correlated with frass weight.

Washing and dry-cleaning reduced the toxicity of the treated cloth substantially and in most cases destroyed the protective value of the insecticide completely. After two washings or three dry cleanings, the mortality dropped to zero except on cloths impregnated with toxaphene or chlordan at high rates, which caused limited mortality. DDT at all rates and methoxy-DDT and toxaphene at the higher ones were the only insecticides that gave complete protection to the cloth after one washing. None of them gave complete protection after two washings, though DDT, toxaphene and chlordan gave limited protection after the second and third washing. DDT at 3 per cent. was the only treatment that gave complete protection after one dry cleaning.

HOFFMAN (R. A.) & LINDQUIST (A. W.). **Fumigating Properties of several new Insecticides.**—*J. econ. Ent.* **42** no. 3 pp. 436–438, 1 ref. Menasha, Wis., 1949.

A fumigating action resulting from space sprays or deposits greatly enhances the value of a contact insecticide for the control of certain insects, particularly those inhabiting enclosed spaces such as houses and warehouses. An account is given of laboratory experiments with deposits, noticed more fully elsewhere [*R.A.E.*, B **38** 98], showing that benzene hexachloride, parathion, chlordan, fluoro-DDT, DDD (dichlordiphenyldichlorethane) and toxaphene have considerable fumigant effect, but DDT none.

PALMER (R. G.). **Size of Screens for Oriental Fruit Moth Bait Jars.**—*J. econ. Ent.* **42** no. 3 p. 438. Menasha, Wis., 1949.

Jars of bait for the oriental fruit moth [*Cydia molesta*, Busck] hung in peach trees in the State of New York in 1948 caught much smaller numbers of moths when the hardware cloth with which they were covered to keep out larger insects had six meshes to the inch instead of the usual four.

BUTLER jr. (G. D.) & CARRUTH (L. A.). **Corn Earworm Control with DDT and other Insecticides.**—*J. econ. Ent.* **42** no. 3 pp. 457–461, 12 refs. Menasha, Wis., 1949.

The authors summarise the results of tests on the control of *Heliothis armigera*, Hb., on sweet maize, carried out in western Long Island in 1945–48. It was shown in 1945 that 1 per cent. DDT dissolved in mineral oil was more effective than 2 per cent. dichlorethyl ether or styrene dibromide in oil when applied once at the rate of 0·6 cc. per ear to the silk channels after the completion of pollination and much more so than single dust applications of 5 per cent. DDT or 4 per cent. *Ryania* to the exterior silks about a week after the mean silking date, but the possible danger to health of residues of DDT dissolved in oil on the kernels appeared too great to permit the general use of such preparations. In 1946, sprays containing 1 or 2 lb. 50 per cent. wettable DDT powder per 100 U.S. gals. gave unsatisfactory control when applied to the silks, and sprays prepared by diluting a 25 per cent. DDT emulsion concentrate to strengths of 2·5 and 5 per cent. were more effective but caused very severe damage to the husks and adjoining foliage. In 1947, when single applications of dust to the silks were tested, 3 per cent. DDT did not give commercial control, though it was more effective than 1, 3 or 5 per cent. DDD (dichlordiphenyldichlorethane), chlordan or toxaphene or 1 or 2 per cent. parathion.

The effect of 1–3 applications of 5 per cent. DDT dust at different times in relation to the mean silking date was tested in 1948. A single application was no more effective than before, but a marked increase in uninfested ears followed the use of 2–3 applications per ear, with no significant differences between two treatments applied 4 and 6, 4 and 8 or 6 and 8 days after the mean silking date. Three treatments appeared to be more effective than two, though the difference was not significant. In two comparative tests in which the dusts were applied 4, 6 and 8 days after the mean silking date, and efficiency percentages for them were calculated from the numbers of uninfested ears on treated and untreated plots, these percentages were 91·6 and 82·3 for 5 per cent. DDT, 74·7 for 3 per cent. DDT (used in the first test only), 71·1 and 68·8 for 4 per cent. DDD, 68·4 and 82·8 for 1 per cent. parathion, 74·2 and 73 for 1 per cent. DDT prepared from an impregnated dust concentrate containing 10 per cent. DDT, 1·2 per cent. pyrethrins and 36·8 per cent. petroleum hydrocarbons, 60 and 76·7 for 10 per cent. toxaphene, 50·5 and 59 for 5 per cent. methoxy-DDT (methoxychlor), 41·6 and 38·7 for 5 per cent. chlordan, and 47·4 and 42·3 for 40 per cent. *Ryania* stem. These dusts were applied with a bellows-type knapsack duster. In an additional test with a hand-operated rotary-type duster equipped with a branched outlet capable of treating two rows at a time, the percentage of uninfested ears was only slightly lower and the dusting operation more rapid and less laborious. The use of power-operated, row crop dusting equipment of adequate axle clearance therefore appears worthy of consideration.

Analysis of ears from plots dusted three times with 5 per cent. DDT showed only negligible DDT residues on the edible portion, although more substantial residues were present on the husks. Similar analysis of ears dusted with 1 per cent. parathion revealed no residues on the husked ears and relatively low parathion residues on the husks.

ELMORE (J. C.). **Hibernation and Host-plant Studies of the Mexican Bean Beetle in California.**—*J. econ. Ent.* **42** no. 3 pp. 464–466, 4 refs. Menasha, Wis., 1949.

Following the discovery of *Epilachna varivestis*, Muls., on lima bean [*R.A.E.*, A **36** 396], in Ventura County, California, investigations on its hibernation sites,

spring activity and alternative food-plants were made between 1st December 1946 and 1st August 1947. Most of the beetles overwintered in shelter near the margins of fields in which they had been feeding at harvest ; their numbers decreased rapidly as the distance from the fields increased and none was found more than half a mile away. They were found in moist places under débris at the foot of various trees [*cf.* **37** 294] and at the base of grape vines and pole beans and by irrigation stand-pipes. The beetles found under walnut trees were commonly associated with wild morning glory (*Convolvulus arvensis*), which remained green throughout the winter ; they apparently sought it for protection as they did not feed on it.

In a hibernation cage containing leaves, put in partial shade to simulate field conditions, slight beetle activity was observed from the middle of February, but activity did not become general until the middle of May, and the last beetle became active on 22nd June. Only 40 per cent. of the caged beetles survived the winter. The first overwintered beetle was found in the field on 13th May, and 92 were found in 40 fields, chiefly during the last three weeks of June. High temperatures of 84–96°F. on 11th–14th April, accompanied by low humidity, did not cause an increase in emergence, and the beetles emerged in numbers only during or after rain or during heavy fogs that left everything damp. However, the rainfall in 1947 was the lowest on record for the coastal area of southern California, and the collection of adults in the lima-bean fields demonstrated that *E. varivestis* can survive severe drought conditions in California and infest the spring crop.

In food-plant tests the beetles would not remain on *Astragalus antisellii*, *Isomeris arborea* or *Malva borealis* and remained but did not feed on *Lathyrus strictus*, *Convolvulus arvensis*, *Lotus salsuginosus*, *L. scoparius*, *Lupinus bicolor*, *L. truncatus*, vetch, alsike clover [*Trifolium hybridum*], sweet clover [*Melilotus*] and broad (horse) beans. Larvae and adults fed on *Lupinus hirsutissimus*, *L. excubitus* and *L. succulentus*, but no reproduction occurred on them.

HETRICK (L. A.). **Some overlooked Relationships of Southern Pine Beetle.**—*J. econ. Ent.* **42** no. 3 pp. 466–469, 9 refs. Menasha, Wis., 1949.

Although outbreaks of *Dendroctonus frontalis*, Zimm., on pines in the south-eastern United States have apparently been caused by deficient rainfall [*cf. R.A.E.*, A **14** 244 ; **19** 94], this bark-beetle killed second-growth *Pinus taeda* over more than 3,000 acres in Marion County, Florida, in 1946 and 1947, when rainfall had been excessive and had brought about a general rise in the level of the water table in the soil. Excessive precipitation continued into 1948, and the outbreak subsided early in that year. Infested bark collected in December 1947 was found to contain dead and dying brood parasitised by a nematode previously observed [**29** 211], but it is not known whether this was responsible for the termination of the outbreak.

In this infestation, excess of moisture had an effect on the trees similar to that of an extended period of deficient soil moisture, and either extreme may bring about conditions within the tree that favour attack by *Dendroctonus*. It is considered that any influences that interfere with the normal functioning of the root system may induce attack by bark-beetles. This opinion is supported by the fact that several instances have been observed of pine trees actively infested by *D. frontalis* and by rhizomorphs of *Armillaria mellea* between the bark and sapwood of the stump region. Callous sapwood growth at points where the mycelium was growing upwards clearly indicated that the fungus preceded the bark-beetle and it is possible that *A. mellea*, other diseases of the roots and root-infesting nematodes may be tree-weakening factors that precede infestation by *D. frontalis*. Further evidence that damage to roots makes the tree attractive to bark-beetles is afforded by a study of lightning

injury. When this runs down the trunk of the tree to the ground, bark-beetle infestation occurs soon after, but if it does not extend to the root system it is not usually followed by attack. Furthermore, in the extensive naval stores forests of the south-eastern United States, turpentine faces constitute a rather severe injury to the trunks but are not followed by bark-beetle attack unless the roots are also injured.

Staining of the sapwood by *Ceratostomella pini* is usually associated with trees killed by *D. frontalis*. The fungus is apparently transmitted from tree to tree by the adult beetles or possibly by mites that are ectoparasitic on them [*cf.* **23** 2] and has been held responsible for the rapid death of the trees [*cf.* **18** 110]. In the outbreak of 1946–48, many infested trees showed no evidence of blue-staining but died rapidly and permitted the development of normal broods of the beetle, and similar observations in other areas indicate that the presence of *C. pini* is not essential for successful attack by *Dendroctonus*.

Many outbreaks of *D. frontalis* have terminated after normal rainfall has been resumed, and the finding of limp and water-logged larvae has been taken as evidence of drowning. In the author's observations, such insects recovered. When infested bark 0·5–1·5 inches thick containing larvae and prepupae of the overwintering generation was kept in tubs of water out of doors, less than half were dead after 36 days, during which air temperatures had ranged from 24 to 83°F. and ice had covered the bark and water on several mornings, but insect activity and brood development stopped soon after the bark was immersed. Larvae of the predacious Clerid, *Thanasimus dubius*, F., failed to revive after 21 days in water. However, since development was arrested and burning the bark of infested trees is difficult and dangerous, it is suggested that infested bark should be deposited in ponds or sluggish streams. Since there would be no need to remove the bark from the water, no adults would emerge and a substantial reduction in population would be effected.

TURNER (N.) & WOODRUFF (N.). **Effect of Formulations of DDT, and of Chlordan on Potato Flea Beetles and Yield.**—*J. econ. Ent.* **42** no. 3 pp. 470–473, 1 graph, 13 refs. Menasha, Wis., 1949.

The authors review the literature on the control of insects attacking potato by means of DDT, from which it appears that sprays prepared from emulsion concentrates are more effective against Aphids and the Colorado beetle [*Leptinotarsa decemlineata*, Say] and those from powders against the potato flea-beetle [*Epitrix cucumeris*, Harr.], and that the latter result in higher yields. In this paper they describe investigations in Connecticut on the possible injury to potatoes from emulsions and the relative effectiveness of emulsions and spray powders against *E. cucumeris*. When emulsified solutions of DDT with the same emulsifier but different solvents were applied to potato three times at weekly intervals, some solvents, including xylene, caused no visible injury whereas others caused moderate or severe injury after one application, and it is concluded that differences in the phytotoxicity of the solvents may account for recorded differences in yield.

In small-plot tests in 1948, sprays prepared from a 50 per cent. DDT spray powder, a 34 per cent. DDT emulsion concentrate and a chlordan spray powder were applied weekly between 8th June and 26th July at concentrations of 0·25–1 lb. toxicant per 100 U.S. gals. to potatoes planted on 4th May. Estimates of damage by the overwintered generation of *E. cucumeris* on 21st June showed reductions of 63·1–87·2 per cent. for the DDT spray powder, 65·5–79·3 for the emulsion and 44·4–67·2 for chlordan, and estimates of damage by the summer generation on 20th July showed 77·9–91·1, 69·6–90·6 and 55·6–87·3 per cent. reduction, respectively. The corresponding plot yields were 104–111, 109–114 and 116–126 lb., as compared with 104 lb. for no treatment.

In a large-scale field test in which the sprays were applied weekly from 15th June to 30th August with a tractor-borne 10-row sprayer, it was obvious that 2 lb. 50 per cent. DDT spray powder per 100 U.S. gals. gave better control of *E. cucumeris* than 1 quart 30 per cent. DDT emulsion concentrate per 100 gals. At about the middle of July, Aphids were more abundant in the spray-powder plots, and a single emulsion treatment was substituted for the next application of spray powder. By 15th August, Aphids were so abundant in both series that nicotine sulphate was added in two treatments, and this controlled them effectively. Yields were greater on plots sprayed with the powder. It thus appears advisable to use DDT spray powders against flea-beetles and emulsions against Aphids in order to obtain the best protection of the plants and the highest yield.

In a further large-scale test, chlordan gave less control of flea-beetles but somewhat better Aphid control than DDT powder and resulted in significantly higher yields. This may indicate that DDT is somewhat injurious to potato plants and chlordan much less so.

VANCE (A. M.). **Some physiological Relationships of the female European Corn Borer Moth in controlled Environments.**—*J. econ. Ent.* **42** no. 3 pp. 474–484, 2 graphs, 12 refs. Menasha, Wis., 1949.

The following is substantially the author's summary. Experiments were carried out in Ohio to determine the effects of different combinations of temperature and relative humidity on adult females of *Pyrausta nubilalis*, Hb. Temperature was controlled in small closed jars within which the humidity was regulated by means of water or potassium-hydroxide solutions.

The average water content of 13 females was 50·7 per cent., and this percentage did not vary materially among moths differing in initial live weights. The heaviest moths deposited the greatest numbers of eggs. The females require water to drink. It is believed that they do not possess, at least in quantity, the enzymes necessary for the digestion of proteins and cane sugars. Four females kept at 80°F. and a relative humidity of only 5 per cent. weighed an average of 26·4 per cent. more each day immediately after drinking water, but at each subsequent weighing prior to drinking they weighed less than at the same time on the previous day. The heaviest female drank the greatest quantity of water at one time.

A temperature of 85°F. and a relative humidity of 96 per cent. were found to be optimum for the ovipositing females. In this environment, 22 deposited an average of 823 eggs per female during their lifetime, the mean life-span being 10·8 days. Moths kept at 70 and 80° and 96 per cent. humidity deposited 708 and 758 eggs and lived for 15·9 and 14 days, respectively, and others kept at 80° and humidities of 50 and 20 per cent. lived for 11·3 and 11·1 days and produced 495 and 505 eggs, but at 80° and a humidity of only 5 per cent. the mean number of eggs dropped to 136 and the length of life to 3·7 days. Moths kept at 80° and 90 per cent. humidity deposited 663 eggs and lived for 13·2 days, whereas those kept at 90° and 96 per cent. humidity laid 533 eggs and lived for 8·8 days. These data indicate that humidity in itself seldom affects oviposition under usual field conditions.

Infertile eggs generally appeared late in the life of the ovipositing moth. The percentage of infertile eggs was less than 1·7 except at 90°F., when it reached 5·7. At 80°, the average survival periods of four groups of moths kept at different relative humidities were inversely proportional to the saturation deficiencies of the environments. In most tests, females laid more than 90 per cent. of their eggs during the first ten days of life. The largest number of eggs laid by a moth in one day was 330, at 85 and 96 per cent. humidity. There was a rapid downward trend from the second to the tenth day of life.

At 96 per cent. relative humidity, sudden changes in temperature, such as daily shifts between 80 and 40°F., had little adverse effect on total egg deposition and survival. Oviposition ceased at 40 and 60°, but was immediately resumed at 70, 80 and 85°. Infertility of eggs at the variable temperatures (8·3 per cent.) was somewhat higher and more frequent than at the constant temperatures (1·1 per cent.). The detrimental effects of prolonged cool spells in the field may be due not to low temperature itself but to continued exposure to other factors such as driving winds, rain and predators, or possibly to some physiological influence on mating responses.

Ovipositing moths kept at 96 per cent. relative humidity and temperatures of 70, 80 and 85°F. and provided with water lost weight daily. It is believed that the loss was due to deposition of eggs, a depletion of the fat reserves and a general breaking down of body tissues or catabolism with no restorative action or anabolism due to intake of food.

Moreno (I.). **Cotton Insect Control with new Organic Insecticides in Mexico.**—*J. econ. Ent.* **42** no. 3 pp. 484–486. Menasha, Wis., 1949.

For several years, farmers in the La Laguna district of Mexico, one of the principal cotton- and wheat-growing areas in that country, have been trying to grow both crops each year on the same land, but although cotton planted in late June, soon after the wheat harvest, produces good stands of seedlings with fast growth and satisfactory production of fruits, the fields serve as a trap crop for insects that develop in the regular cotton fields planted in March and April and become so heavily infested that no cotton can be picked.

Field investigations were therefore carried out in 1948 to see whether insecticides would give satisfactory control. The most important pests in the district are *Platyedra* (*Pectinophora*) *gossypiella*, Saund., *Heliothis armigera*, Hb., a Pentatomid of the genus *Chlorochroa*, *Aphis gossypii*, Glov., and *Anthonomus grandis*, Boh. Field examinations of cotton planted on 24th June showed that 20 per cent. of the squares were punctured by *A. grandis* on 17th August, and applications of 15 lb. per acre of a dust mixture containing 2 per cent. γ BHC (benzene hexachloride) and 10 per cent. DDT were made weekly from that time. These controlled the weevil until 31st August, although it still increased on untreated plots, but heavy rains during early September then prevented treatment. When the soil was dry enough for further collection of squares, plant growth was so dense and weevil infestation so heavy that treatment with a dust containing 6 per cent. γ BHC from an aeroplane was substituted. This reduced the weevil, but after three applications, on 23rd and 28th September and 3rd October, infestation of bolls by *P. gossypiella*, which, like *Heliothis*, had hitherto been unimportant, increased to 33 per cent., and applications of the mixture at seven-day intervals were therefore renewed and continued until 26th October. These prevented any further increase of *P. gossypiella* for the rest of the season, and the weevil continued to decrease. Aphids practically disappeared from the treated plot after the first application of DDT and BHC, but became so numerous on the controls that they stunted the plants and caused heavy damage to the crop. It was impossible to distinguish boll damage by *Anthonomus*, *Platyedra* or the Pentatomid on the untreated plot owing to the extremely heavy total infestation.

During the first fortnight of November, a frost killed all the leaves, young bolls and terminal buds, destroying about 30 per cent. of the crop, and on 16th November cotton was picked for the first time from the treated plot. The yield averaged 880 lb. seed cotton per acre, whereas no bolls in the untreated plot were worth picking.

It is concluded that planting cotton late in the season is unprofitable. Although insect pests can be controlled, the high populations make it necessary to apply

insecticides twice as often as in normally planted cotton fields and early frosts may so reduce the yield that the final crop will not pay for the cost of insecticides or cultivation.

SMITH (R. F.) & ALLEN (W. W.). **Chemical Control of the Alfalfa Caterpillar in California.**—*J. econ. Ent.* **42** no. 3 pp. 487–495, 20 refs. Menasha, Wis., 1949.

Although the total value of the lucerne crop in California is high, that of each cutting is low, so that little can be spent on the control of *Colias eurytheme*, Boisd., and other injurious insects. The insecticides that can be used are limited by residue hazards to man, livestock and beneficial insects, and since natural factors are so effective against *C. eurytheme* [*cf. R.A.E.*, A **33** 81], chemical control is warranted on only a small proportion of the total acreage. In the San Joaquin Valley, nearly all damage is restricted to a part of the third, fourth and fifth crops, and economic control is obtained in most fields by early cutting. Nevertheless, the lack of a satisfactory insecticide to supplement natural control has caused the loss of many acres of lucerne hay.

The authors review the history of the chemical control of *C. eurytheme*, with particular emphasis on the use of new organic materials, and describe experiments carried out in the San Joaquin Valley in 1946–48. Single applications of sprays or dusts were made by aeroplane in July–September. The results showed that DDT gave very effective control at remarkably low dosages and was more rapid in action than sulphur dusts [*cf.* **32** 194], which also proved very effective. Applications of 25 lb. 1 per cent. DDT dust or 0·15 lb. DDT in a spray emulsion per acre gave satisfactory control of the most severe infestations, and applications of about 30 lb. 0·5 per cent. DDT dust or 0·1 lb. DDT in a spray per acre appeared adequate against lighter ones. The smaller dosages did not kill the fourth- and fifth-instar larvae so rapidly as the higher ones, but the mortality of smaller larvae and the total mortality after 48 hours was satisfactory except under the most severe conditions. They should therefore be applied before most of the larvae have reached the fifth instar. Published data on the residues are recapitulated [**38** 21]. DDD was not quite as effective as DDT, but dosages as low as 25 lb. 1 per cent. dust and 0·13 lb. in a spray per acre proved satisfactory ; the residue hazard from this compound is less than that from DDT.

Preliminary tests were also made with dusts containing 5 per cent. technical chlordan, 0·5 or 1 per cent. γ BHC (benzene hexachloride) with 3·5 or 7 per cent. other isomers, respectively, 10 per cent. technical chlorinated camphene [toxaphene], 3 or 5 per cent. methoxy-DDT (dianisyl trichlorethane), 0·5 or 0·66 per cent. tetraethyl pyrophosphate with 1 per cent. other related organic phosphates, 0·5 per cent. piperonyl cyclonene with 0·25 per cent. rotenone or 0·05 per cent. pyrethrins, and 1 per cent. parathion, but they either gave less control than DDT or presented a more hazardous residue problem ; Compound 118 [1,2,3,4,10,10-hexachlor-1:4,5:8-diendomethano-1,4,4a,5,8,8a-hexahydronaphthalene] was tested in emulsion sprays, but was not very effective.

In tests in 1946, 0·5 per cent. DDT in sulphur or inert material was compared with sulphur alone. All three dusts gave good control, but all, especially those containing sulphur, reduced the numbers of adults of *Apanteles medicaginis*, Mues. [**37** 333], though the parasite population again equalled that in the untreated area after six days.

WILSON (M. C.). **Organic Insecticides to control Alfalfa Insects.**—*J. econ. Ent.* **42** no. 3 pp. 496–498. Menasha, Wis., 1949.

In preliminary investigations on the effect of insect control on lucerne seed production in Indiana in 1948, single spray applications were made to the

second crop on 12th July, just before the plants came into flower. Sprays prepared from wettable powders were applied to give 2 lb. DDT, 1 lb. chlordan, 1·5 lb. of a mixture of 1 lb. DDT and 0·5 lb. chlordan, 1 lb. methoxy-DDT (methoxychlor) or 0·5 lb. parathion per acre, and insect populations were determined one and four weeks after treatment. Solitary bees are the most valuable pollinators of lucerne, and Andrenids were abundant in the field. Two hives of honey bees were put near the experimental plots to help the natural pollinators. No mortality of bees was noted as a result of insecticidal action, and one week after treatment the treated plots attracted many more bees than the untreated plots owing to the increased bloom ; the bee population continued high on the treated plots over the four-week period. The most important injurious insects present were *Empoasca fabae*, Harr., *Agallia* sp., Cercopids, *Lygus oblineatus*, Say, *Adelphocoris lineolatus*, Goeze, and *A. rapidus*, Say. All the materials except chlordan alone gave very high control of *Empoasca*, with a long residual effect, but chlordan alone seemed to attract the leafhoppers, as there was 140 per cent. increase in population after one week and 213 per cent. after four, and the plants on the chlordan plot were much more severely damaged than those on untreated plots. No examples of *Agallia* were found one week after treatment, but there were a few after four weeks, when DDT, methoxy-DDT and parathion were giving highly significant control. Like *Empoasca*, *Agallia* increased on the plots treated with chlordan only. All the materials gave highly significant control of adult Cercopids for the first week, methoxy-DDT giving significantly better control than parathion and slightly but not significantly better control than DDT and chlordan. Four weeks after treatment there was no significant difference between treated and untreated plots. Chlordan and DDT, alone or together, gave significant and parathion highly significant control of *Lygus* and *Adelphocoris* during the first week, and all three were giving highly significant control after four weeks, but methoxy-DDT was completely ineffective.

Yield records showed that the treatments effecting the highest pest control resulted in the largest numbers of seed-pods per stem, which confirms the view that although the insecticides are highly toxic to bees, danger to them can be eliminated by applying treatment when the bees are not present in the field [*cf. R.A.E.*, A **38** 67]. The mixture of DDT and chlordan resulted in the highest number of seed pods and the highest yield of seed (more than twice that on untreated plots), and DDT alone and parathion also gave significant increases. Chlordan alone resulted in the smallest seeds (755 per gm.) and parathion in the largest (622 per gm.).

SCHREAD (J. C.). **A new Chlorinated Insecticide for Control of Turf-inhabiting Insects.**—*J. econ. Ent.* **42** no. 3 pp. 499–502. Menasha, Wis., 1949.

The results are given of tests of Compound 118 (1,2,3,4,10,10-hexachlor-1:4,5:8-diendomethano-1,4,4a,5,8,8a-hexahydronaphthalene) against insects that infest turf, made in Connecticut in 1948.

On 11th August, 40, 120 and 240 lb. 2·5 per cent. dust per acre were applied with 800 lb. fertiliser to facilitate distribution ; 2·55 inches rain fell during the first 24 hours after treatment. All treatments gave high mortality of larvae of the Japanese beetle [*Popillia japonica*, Newm.] within ten days and prevented turf injury. By 22nd September, no grubs were found in the treated plots, but in the untreated ones there were 25 per sq. ft. and turf injury was severe ; eggs were laid in treated sod. A 25 per cent. wettable powder applied at the rate of 48 lb. per acre with 80 lb. fertiliser on 31st August gave complete kill in 28 days without damaging the turf, although the insecticide remained on the dry surface in direct sunlight for virtually 12 days before being wetted by rain and only 0·42 inch rain fell during the remainder of the time. A 2·5 per

cent. dust applied at 150 lb. per acre with fertiliser on 23rd September reduced infestation from 75 to 9·6 larvae per sq. ft. in two weeks, during which 0·52 inch rain fell. Larval mortality was less rapid at that season, when the soil temperature averaged 67°F. at a depth of three inches, than in summer, when it averaged 84·5°, partly owing to temperature but also owing to the difference in rainfall. The 2·5 per cent. dust was also applied on 23rd September at 200 lb. per acre to turf containing 20 larvae of *P. japonica* and 33·3 of *Aserica* (*Autoserica*) *castanea*, Arr., per sq. ft. and gave 95·2 and 91·7 per cent. mortality of the two species, respectively, by 28th September. Comparison with results obtained with parathion and chlordan in 1947 [*cf. R.A.E.*, A **37** 395] showed that at a concentration of 1 lb. per acre in August, Compound 118 gave better control of *P. japonica* than parathion in ten days, and that at 3 and 6 lb. per acre it was at least as effective as parathion at 4 and 8 lb. At 1, 3 and 6 lb. per acre, Compound 118 caused greater reductions in grub populations in ten days than 1, 5 and 10 lb. chlordan, respectively, in longer periods.

During the summer and early autumn of 1948, *Blissus hirtus*, Montd., was more widespread and destructive to turf than for several years, causing extensive permanent injury in many localities. On 5th August, dusts of 2·5 per cent. Compound 118 and 5 per cent. chlordan were applied to turf plots at the rate of 5 lb. per 1,000 sq. ft., DDT with sabadilla at 2·3 lb. and DDT alone at 6 lb., all with fertiliser at 20 lb. per 1,000 sq. ft. About 0·5 inch rain fell immediately after treatment, but did not appear to retard or impair control. On 11th August, the plots treated with Compound 118 and chlordan were free from infestation, and the turf on them was recovering, but there were a number of active bugs in the other plots. The first three plots were free from infestation by 15th August, and the fourth by 21st August. Weekly examinations until the end of September showed that the first two plots remained uninfested, but there were a few adults on the DDT plots eight weeks after treatment. Adjacent untreated turf remained infested throughout August and September but did not constitute any serious threat to the treated plots.

On 23rd August, a putting green 4,500 sq. ft. in area that was infested with 6,500 colonies of *Lasius niger* var. *americanus*, Emery, was treated with a wettable powder containing 25 per cent. Compound 118 at the rate of 4 oz. powder in 200 U.S. gals. water per 1,000 sq. ft., after which the turf was thoroughly watered for 30 minutes. At the time of treatment, the temperature was 90°F. and humidity was high. Examination 24 hours later showed that the infestation had been eliminated ; on 1st September, three ant hills appeared on the western edge of the treated green, but no more were seen for the rest of the season. A mound 5 ft. in diameter constructed by *Formica exsectoides*, Forel, was dusted with 1 oz. 25 per cent. wettable powder mixed with 1 lb. dry sifted sand to facilitate distribution, and the surface of the mound was scratched lightly to a depth of about an inch. The ants became agitated almost immediately, and 24 hours later large numbers of dead and dying worker ants, together with larvae and pupae, were found in the entrance-ways of the mound. By the second day, all activity had ceased and no living ants were found in excavated portions of the mound or subterranean galleries. The undisturbed portions of the colony were examined periodically for the remainder of the season, but no living ants were found.

The 2·5 per cent. dust, the 25 per cent. wettable powder and an emulsifiable concentrate of Compound 118 were applied at dosages of 1–12 lb. actual toxicant per acre without injuring various grasses. On one occasion, when the air temperature was 104°F., both the dust and wettable powder were applied dry and mixed with fertiliser to parts of a golf green at 10 lb. technical toxicant per acre and the turf was watered thoroughly. The highest air temperature averaged 100°F. during the next three days, and no rain fell for six days. No injury to the turf was observed.

Hofmaster (R. N.) & Greenwood (D. E.). **Fall Armyworm Control on Forage and Truck Crops.**—*J. econ. Ent.* **42** no. 3 pp. 502–506, 2 refs. Menasha, Wis., 1949.

Although infestation by the fall armyworm, *Laphygma frugiperda*, S. & A., is of regular occurrence in Virginia, extensive damage is usually limited to a comparatively short period in late summer, but in 1948, when extremely heavy outbreaks developed, the larvae were so numerous by 1st July that entire fields of maize were destroyed, and became much more numerous by 1st September. Since the usual control measures with poison-bran baits are not completely satisfactory, direct applications of several organic insecticides as sprays and dusts were tested. On 8th July, late maize eight to ten inches high, in which many fifth- and sixth-instar larvae were feeding deep within the whorls, was treated with 35 lb. dust per acre. Dusts containing 2, 1 and 0·5 per cent. parathion, 1 per cent. γ BHC (benzene hexachloride) and 3 per cent. DDT reduced the number of larvae per 100 plants by 97, 79, 79, 81 and 78 per cent. and the percentage of plants infested by 90, 69, 68, 74 and 65 in 24 hours. An impregnated dust of 2·5 per cent. methoxy-DDT (methoxychlor) and dusts of 3 per cent. chlordan, 5 per cent. toxaphene and 5 per cent. methyl-DDT (ditolyltrichlorethane) were less effective. DDT was considered to have the best possibilities for general use in armyworm control, and experiments against marching bands in sorghum showed that 3 per cent. impregnated DDT and 5 and 3 per cent. regular DDT gave 96, 92 and 78 per cent. mortality ; large-scale emergency applications of a DDT spray at the rate of 2 lb. 50 per cent. wettable powder in 40 U.S. gals. water per acre gave satisfactory results on both maize and sorghum.

On pasture land, to which the dusts were applied with a tractor-drawn duster with a 25-ft. cloth trailer, one application on 6th August of 2 per cent. parathion, 5 per cent. regular DDT and 3 per cent. impregnated DDT at 33–38 lb. per acre gave 100, 98 and 99 per cent. kill in 24 hours, and 1 per cent. parathion and 5 per cent. toxaphene at 41 and 34 lb. per acre, respectively, gave 86 and 81 per cent. ; 20 per cent. toxaphene, 5 per cent. chlordan and a mixture containing 1 per cent. DDT and 0·5 per cent. parathion at about 40 lb. per acre were less effective, though all gave significant control. All the dusts containing parathion killed large numbers of the first- and second-instar larvae of the Japanese beetle [*Popillia japonica*, Newm.] feeding just below the soil surface. It was subsequently found that DDT permitted reinfestation of pasture land by armyworms within three to four weeks, and since it might not be safe to graze cattle on treated land within that period, further materials were tested in sprays and dusts. Of these, tetraethyl pyrophosphate (used in sprays) and DDD (dichlordiphenyldichlorethane) were the only ones showing promise, and owing to slight foliage injury to clover, tetraethyl pyrophosphate was not considered further. Applications of 2–4 lb. 50 per cent. DDD wettable powder per 50 U.S. gals. water per acre to 20 acres of grazing land on 27th August, when the larvae had not passed the third instar, resulted in 98–100 per cent. kill in 24 hours of populations of 35–50 per sq. ft., and a 5 per cent. DDD dust applied at 40 lb. per acre gave comparable results. In view of its lower toxicity to warm-blooded animals, substitution of DDD for DDT may permit a quicker resumption of grazing on treated pasture.

Kale, collards and other crucifers are commonly planted in Virginia in mid- or late summer and harvested at various periods throughout the autumn, winter or spring. The young plants are very susceptible to armyworm injury and considerable damage has occurred in the past despite the use of poison-bran baits. DDT dusts and sprays were applied to about 500 acres of kale and collards in 1948, and notwithstanding one of the heaviest infestations on record, damage by armyworms was negligible.

Predators were more or less active throughout the season, and gave very effective control of localised infestations at times. Near Oceana, several species of Carabid larvae reduced armyworm populations in 39 acres of sorghum in late July to such an extent that insecticidal treatment was unnecessary. Larvae of *Calosoma calidum*, F., comprised about 75 per cent. of the total, and *C. scrutator*, F., *C. sayi*, Dej., and *Harpalus pennsylvanicus*, Deg., were also present. From time to time throughout the season, numerous predators, including *Megacephala* (*Tetracha*) *carolina*, L., *Cicindela sexguttata*, F., *Nabis ferus*, L., *Podisus maculiventris*, Say, and several unidentified dragonflies and wasps, were observed. Parasites did not cause marked reductions in populations until early September, when they became so effective as to eliminate the need for further control measures in many places. *Apanteles marginiventris*, Cress., other species of *Apanteles* and *Winthemia rufopicta*, Big., predominated. Secondary parasitism of *Apanteles* was very common, emergence records indicating that as many as 75 per cent. were parasitised by *Eupteromalus viridescens*, Walsh; other secondary parasites noted were *Catolaccus aeneoviridis*, Gir., *Ceratosmicra meteori*, Burks, and *Mesochorus discitergus*, Say.

Cox (J. A.). **Field Experiments for Control of the Grape Berry Moth.**—*J. econ. Ent.* **42** no. 3 pp. 507–514, 6 refs. Menasha, Wis., 1949.

Polychrosis viteana, Clem., is one of the major pests of grapes in the Erie Grape Belt, and often causes severe damage to the crop. The accepted method of control has been to apply sprays of lead arsenate or calcium arsenate in the early part of the season and of fixed nicotine later, but in recent years, DDT sprays have shown promise [*cf. R.A.E.*, A **37** 292, etc.], and experiments were carried out near North East, Pennsylvania, in 1944–48 to compare some of the newer organic insecticides with the standard treatment. The sprays were applied at 175–225 U.S. gals. per acre with a power sprayer and a covered inverted U-shaped boom carrying five to seven nozzles on each side of the row and so arranged that the spray from the nozzles was directed upwards and into the foliage and clusters of the vine. Miscible oil was usually included. The following is based on the author's discussion and summary.

The results showed that DDT, used at the rate of 0·75 lb. per 100 U.S. gals. in three sprays, applied just after the berries set, ten days later and when the berries touched in the clusters, gave satisfactory control of *P. viteana* and were more effective than three of 3 lb. lead arsenate with 12 oz. nicotine sulphate in the first two. In heavily infested vineyards, three applications of DDT appeared to be as effective as four, and two gave satisfactory control when applied on the first and third dates but not when applied on the first and second. Field experiments indicated that it would be advisable to apply three sprays of DDT in heavily infested vineyards for at least one season; after the moth population has been reduced to a low level, two DDT sprays should give ample protection. DDD (dichlordiphenyldichlorethane) was as effective as DDT when used at the same concentration, and experiments for two seasons indicated that parathion was quite effective when applied three to four times at 0·25–0·45 lb. per 100 U.S. gals. No injury to the fruit or foliage of the Concord grape resulted from sprays of DDT, DDD or parathion. Sprays of phenothiazine, BHC (benzene hexachloride), toxaphene and chlordan did not appear to be effective against *P. viteana*; toxaphene and chlordan scorched the foliage severely, and grapes sprayed with BHC were not suitable for eating as fresh fruit or for processing into grape juice.

The spray residue at harvest is likely to be high on grapes that have received four applications of DDT at 0·75 lb. per 100 U.S. gals. and an oil. No legal tolerance has been established for DDT residues on grapes, but the residues remaining from three applications of this concentration of DDT are

approximately the same as those permitted for lead (seven parts per million). Two DDT sprays leave a residue at harvest well under that limit, and since most of the vineyards in the Erie Grape Belt receive only two applications of DDT, it is not likely that the spray residue on grapes from them will be of major importance.

CHANDLER (S. C.). **Chlordan and Benzene Hexachloride for Control of Plum Curculio on Peach.**—*J. econ. Ent.* **42** no. 3 pp. 514–518. Menasha, Wis., 1949.

The following is mainly from the author's summary. Large-scale tests with dusts and sprays of chlordan and BHC (benzene hexachloride) in comparison with lead arsenate for the control of *Conotrachelus nenuphar*, Hbst., on peach were carried out in six orchards in southern Illinois in 1947 and in seven in 1948. BHC was used as the technical product (12 per cent. γ isomer) and in a refined form with the isomers other than γ removed, both at rates giving 2·88 oz. γ isomer per 100 U.S. gals. in the sprays, and 1 per cent. in the dusts. The methods used to determine comparative efficiency comprised jarring, collecting and examining drops and making harvest infestation records. The most effective treatments were 6–7 applications at intervals of 7–10 days of a spray containing 1 lb. chlordan per 100 U.S. gals. or the spray or dust of technical BHC. These treatments were 3–10 times as effective as lead arsenate, which was used at 3 lb. per 100 U.S. gals. in sprays, and 10 per cent. in dusts. Lengthening the intervals between sprays decreased effectiveness, especially for BHC, as did halving the concentration of chlordan. The refined BHC was less effective in sprays and dusts than the technical grade, and a 5 per cent. chlordan dust was inferior to the spray of 1 lb. chlordan per 100 U.S. gals.

The jarring data indicated that the value of BHC lies more in its ability to kill larvae in the dropped fruits than in the kill of adults [*cf. R.A.E.*, A **38** 155, 207] and that chlordan kills more of the overwintered adults than BHC, this probably accounting for the fewer punctures by them in plots treated with chlordan. There was decidedly more infestation by the oriental fruit moth [*Cydia molesta*, Busck] in dropped peaches from trees sprayed with BHC or chlordan than in those from trees treated with lead arsenate.

In tasting tests, three of nine samples of raw and cooked peaches sprayed with technical BHC had a musty flavour, but two of the three had been sprayed late into the second-brood period. No off-flavour was detected from any other treatment, including BHC dust. Other tests showed that technical BHC caused the greatest amount of tainting.

BOHART (G. E.) & LIEBERMAN (F. V.). **Effect of an experimental Field Application of DDT Dust on** *Nomia melanderi*.—*J. econ. Ent.* **42** no. 3 pp. 519–522, 5 refs. Menasha, Wis., 1949.

It has generally been assumed that populations of native wild bees react in much the same manner as honey bees to field applications of insecticides, but since the many species of wild bees differ widely among themselves and from honey bees biologically, particularly as regards social behaviour, it is likely that, although individual bees of the various species might be similarly affected by insecticides, populations would not. The effect of an application of DDT dust on *Nomia melanderi*, Ckll., in a field of lucerne near Delta, Utah, was investigated. *N. melanderi* is a very efficient pollinator of lucerne. It nests in the ground in large aggregations and is active in July and August in the intermountain states, where two and possibly three generations are produced in a season. Larvae of the last brood overwinter in their cells as prepupae and

pupate shortly before emergence in the following July. Each female constructs and provisions its own nest, and therefore destruction of a field bee by DDT or other contact insecticide stops progress on a nest and leaves it unprotected from parasites and other destructive agents. The experimental lucerne field, which was the only one within a radius of several miles and was near a nesting site of *Nomia* estimated to contain 25–50 thousand nests, was dusted with 3 per cent. DDT in a mixture of frianite and talc (1 : 4) at the rate of approximately 20 lb. per acre on 31st July 1948 between 6.30 and 7.30 a.m. before *Nomia* bees were on the lucerne. The plants were in early full bloom and remained attractive to the bees for another week. It was ascertained that more than 50 per cent. of the females in the nesting site visited the lucerne on the day it was dusted. The evidence indicated that the dust was moderately repellent to the bees for a few hours. More than 2 per cent. of the females nesting in sample areas were found dead at their nest entrances after the dusting, and about 15 per cent. of the nests in the same areas became inactive, apparently as a result of the treatment. Since mortality resulted from a light application of DDT before the bees were in the field, it is considered that this insecticide should be used with caution on areas in which *Nomia* bees may nest or forage.

HÄFLIGER (E.). **Comparative Toxicity of various Insecticides to the Honeybee.**—*J. econ. Ent.* **42** no. 3 pp. 523–528, 2 graphs, 5 refs. Menasha, Wis., 1949.

Since it had been demonstrated by the author in qualitative contact experiments that the high biological temperature of honey bees gives them a considerable resistance to the action of DDT, he carried out experiments on the influence of temperature on the toxicity to them of various insecticides as stomach poisons. The bees were taken from the hive in July and August and starved for 24 hours before being fed individually with 50 per cent. sugar solution containing different concentrations of DDT, calcium arsenate or BHC (benzene hexachloride containing 10 per cent. γ isomer) in wettable powders or parathion in an emulsion. After feeding, the bees were kept in cages containing 50 per cent. sugar solution at constant temperatures of 20, 28 and 36°C. [68, 82·4 and 96·8°F.] and 60 to 80 per cent. relative humidity, and the number of dead bees was recorded daily for four days.

The median lethal dose (MLD) of DDT in wettable powder depended largely on temperature, increasing from 32 mmg. per bee at 20°C. to 560 mmg. at 36°. This effect is of considerable practical importance, as bees usually live in the upper part of the temperature range examined. The hive temperature remains fairly constant at between 34 and 36°C. [93·2 and 96·8°F.] from February to September, and the biological optimum temperature probably lies between 28 and 30°C. [82·4 and 86°F.]. Individual bees that are exposed to a lower external temperature (such as workers gathering pollen) can develop a body temperature considerably above that of their surroundings through muscular work. Calcium arsenate seemed to be more toxic at higher than at lower temperatures, its MLD per bee decreasing from about 10 mmg. at 20°C. to about 5 at 36°. Its poisonous action developed very slowly, reaching a maximum in two to four days, as compared with one to two days for the other insecticides tested. The toxic effect of γ BHC showed no outstanding dependence on temperature, though resistance appeared to be at a maximum at the optimum biological temperature. It appeared to be 100–250 times as toxic as DDT in the normal biological temperature range. The course of poisoning and the influence of temperature were similar for parathion, but it was approximately three times as toxic as γ BHC.

To determine the influence of physical properties on toxicity, experiments were carried out with four different preparations of DDT. The results showed that its toxicity increased with decreasing particle size and consequently with

increasing solubility. It was about 20 times as toxic in an emulsified solution as in a suspension of commercial 50 per cent. wettable powder, these being the forms in which it was most and least toxic. Very fine DDT crystalline needles 1–2 μ long (pseudocolloidal), precipitated from alcohol in aqueous sugar solution, were more toxic than an experimental preparation consisting of a suspension of finely ground wettable powder composed of almost isodiametric particles 1–2 μ in diameter. The influence of temperature was approximately the same for all four preparations. Combination of the factors of temperature and particle size yielded (within the limits of the experiments) absolute MLD values lying between 1·5 mmg. for the emulsified solution at 20°C. and 560 mmg. for the 50 per cent. wettable powder at 36°C., showing clearly that any experimental value, such as the MLD, can give no definite information without reference to the conditions under which it was determined.

Absolute toxicity expressed as the MLD is important for determining the danger associated with an insecticide in practice, but the extent of exposure (dosage and concentration in use) is no less important. It is therefore necessary to take account of both, and for this purpose the author introduces, as an index of danger, the figure obtained when the concentration of the insecticide applied to crops is divided by the concentration represented by the MLD in 10 cu. mm. Substantially more reliable deductions regarding practical danger can be made from this index than from MLD value alone. The higher the index, the greater the danger of poisoning. Calcium arsenate, which is recognised as being one of the most dangerous insecticides, is shown to have an index of 8–10, and parathion, which has a similar index (10–11), must therefore also be classed as very dangerous so long as there is no practical evidence to the contrary. BHC, with an index of 3–5, is somewhat less dangerous than calcium arsenate, but there is definite practical evidence that it can be extremely dangerous to bees when used on crops. DDT has indices of about 0·5 as an emulsified solution and 0·03 as a wettable-powder suspension, and this is in agreement with practical experience, since DDT products have caused no poisoning of bee colonies in spite of their intensive use all over the world, whereas arsenates have been stated to poison over 1,000 per year in the United States alone.

Calculation of the index is based on the two most important factors governing danger under practical conditions, but other factors can also play a part, the danger being diminished for insecticides that have a simultaneous repellent action (nicotine) or decompose rapidly (rotenone and pyrethrum) and augmented for those that have a high vapour pressure (BHC and parathion), cumulative action (arsenates) or long persisting action. In some insecticides, these factors partly neutralise one another, and a final judgement of the practical danger can therefore be based only on evidence derived from practice, though the index is useful for a preliminary evaluation of new insecticides.

GILBERT (E.), LANGFORD (G. S.) & VINCENT (R. H.). **Automatic Traps for killing Japanese Beetles.**—*J. econ. Ent.* **42** no. 3 pp. 537–539, 1 fig., 1 ref. Menasha, Wis., 1949.

The authors describe and illustrate modifications of the automatic trap for the control of the Japanese beetle [*Popillia japonica*, Newm.] in use in Maryland [*R.A.E.*, A **34** 245], which kills the beetles passing through it and thereby eliminates much of the labour and time consumed in visiting the traps and destroying the captured beetles. The first modification, in which 5 per cent. DDT was incorporated in each of eight attracting mixtures placed at the base of the trap funnel and the standard baffle was replaced by a solid one, killed 84–93·7 per cent. of the beetles passing through it, the highest mortality being given by DDT in a mixture of geraniol and eugenol (9 : 1), whereas the typical automatic trap with 5 per cent. DDT in Deobase oil as the killing agent

killed an average of 98·6 for the eight attractants. The second modification, in which the standard baffle was used but the funnel was replaced by a flat metal plate on which paper, etc., treated with DDT or a smear containing DDT could be placed, gave kills ranging from 62 to 97 per cent., depending on the nature of the killing surface. Mortality was highest with soft corrugated paper soaked in a saturated solution of technical DDT in ether, and almost as good with the same paper soaked in a saturated solution of DDT in axle grease and ethylene dichloride (1 : 2) or soft absorbent blotting paper soaked in a solution of DDT in ethylene dichloride. Three control traps of the typical automatic type with DDT and axle grease (1 : 2) in a salve tin at the base of the funnel killed an average of 99·4 per cent.

Allen (H. W.) & Yetter jr. (W. P.). *Bassus diversus*, **an Oriental Fruit Moth Parasite established in the United States.**—*J. econ. Ent.* **42** no. 3 p. 540. Menasha, Wis., 1949.

Agathis (*Bassus*) *diversa*, Mues., which was imported from Japan in 1933 and propagated and widely distributed in the eastern United States for the control of *Cydia* (*Grapholitha*) *molesta*, Busck, from 1934, freely attacked the larvae in peach twigs immediately after release, so that more than 20 per cent. parasitism was not uncommon. The rate of parasitism invariably decreased in the succeeding generations, however, and the parasite seemed to disappear from the twig-infesting larvae about a year after colonisation. Distribution in southern New Jersey was therefore discontinued in 1939. In 1940–47, no example of this parasite was reared from many thousands of larvae collected from peach twigs in that area, but seven emerged in 1943, one in 1944 and 50 in 1948 from overwintered cocoons of several hundred larvae of *C. molesta* obtained from fallen peach fruits late in the preceding years, and it was thus shown that the parasite was present in two localities near Moorestown in 1947. Although in Japan it attacks larvae of *C. molesta* in peach twigs in spring and midsummer, it apparently followed this habit for only a short time after it was liberated in New Jersey and then restricted its attacks to the larvae attacking the fruit in late summer and early autumn. The alternative host in which it must presumably breed during the rest of the year has not yet been discovered.

Allen (H. W.). **A Japanese Weevil appears in damaging Numbers.**—*J. econ. Ent.* **42** no. 3 p. 540, 1 ref. Menasha, Wis., 1949.

A weevil found feeding heavily on a hedge of California privet [*Ligustrum ovalifolium*] at Moorestown, New Jersey, in July 1946 was identified as *Pseudocneorrhinus bifasciatus*, Roel., an introduced Japanese species [*cf. R.A.E.*, A **36** 301] that was first found in the United States near Philadelphia in 1914 and has since been collected at scattered localities in Connecticut, New York, Pennsylvania and the District of Columbia. Reports indicate damage to a few plant species and scattered feeding on several others.

In August 1948, the weevil was again found feeding near the same place, having practically defoliated about 50 ft. of California-privet hedge and fed to a moderate extent on neighbouring lilac, Japanese barberry [*Berberis thunbergii*], rose, perennial veronica, geranium and lily of the valley [*Convallaria majalis*]. Preliminary tests with several insecticides indicated that chlordan was likely to prove more effective than benzene hexachloride, DDT or lead arsenate in controlling it.

Shelford (V. E.). **Termite Treatment with aqueous Solution of Chlordan.**—*J. econ. Ent.* **42** no. 3 p. 541. Menasha, Wis., 1949.

Dead and partially dead stubs of *Forsythia* sp. on three sides of a house in Urbana, Illinois, were found in 1947 to have been tunnelled by termites. Stubs

of *Parthenocissus*, *Symphoricarpus*, *Spiraea* and *Ligustrum* growing close to the *Forsythia* were untouched, but a stump of *Ailanthus*, partly surrounded by a living tree, and the trunks and roots of half dead trees were heavily infested and tunnelled. The lower wooden step of a porch of the house was also infested. All the *Forsythia* within 15 ft. of the house and the *Ailanthus* trees, roots and stumps were removed, the soil was treated with a 0·25 per cent. aqueous solution of chlordan, and the outside walls of the house were treated with 1 per cent. chlordan in aqueous emulsion by means of special equipment that applied the liquid near the bottom of the foundation under pressure from a special pipe thrust down to that level ; the interior of the foundation, porch footings and chimney bottoms were also treated. The work was completed in early September 1947, and tests were made in November 1948 to determine the persistence of toxicity, by confining termites with soil taken from near the house. Soil samples taken at depths of 0·5–5 inches and distances of 0·5–5 inches from the wall caused paralysis in 2–30 hours and all paralysed termites died in about 24 hours, whereas termites confined with untreated sandy garden soil were alive and active after ten days and those enclosed with a few slivers of wood were still alive after a month.

Large pieces of cherry, *Forsythia* and *Ailanthus* wood and small pieces of cherry and *Ailanthus* were put near an old colony of termites under a glass-roofed building at about the beginning of October 1947 and examined on 5th November 1948. *Ailanthus* was the most severely damaged and *Forsythia* the least. A cherry tree 65 ft. from the house with a concrete repair in one side and a partially rotten heart was infested with termites and also with *Camponotus herculeanus pennsylvanicus*, Deg., and two smaller species of ants ; the tunnels of the different species were separated by the vascular rays of the wood. It was treated by boring three holes into the dead wood above the concrete patch and introducing 2 U.S. gals. 0·25 per cent. aqueous chlordan. Inspection of the lower part of the decayed centre showed that all termites and small ants were dead ; large numbers of *C. h. pennsylvanicus* left one of the top openings and fell to the ground.

Osburn (M. R.). **Tests of Parathion for Control of the Little Fire Ant.**—*J. econ. Ent.* **42** no. 3 p. 542, 4 refs. Menasha, Wis., 1949.

Wasmannia auropunctata, Roger, is a nuisance to workers in *Citrus* and guava groves in southern Florida [*cf. R.A.E.*, A **38** 80], and parathion was tested for its control in St. Lucie County in 1948. It was applied to orange trees with a power sprayer at concentrations of 1 and 2 lb. 25 per cent. wettable powder per 100 U.S. gals. water on 28th June. Some trees were entirely covered with a thorough application of 8 U.S. gals. spray each and others were treated with 2 U.S. gals. on the trunks only. Observations until 7th September showed that all treatments gave significant control with no significant differences between them. The lower concentration applied to the trunk only gave satisfactory control until 26th July, and the other treatments complete control until that date and moderate control until 24th August, but none of the treatments would be considered satisfactory after the first few weeks by a grove worker, since comparatively small numbers of the ants may be troublesome. The results against other pests of *Citrus* indicate that parathion may have a place in the regular spray schedule if it can be used safely, and in such a case, considerable incidental control of *W. auropunctata* would probably result. Thorough applications to the entire tree against other pests would be expected to control the ant for about eight weeks. If the ant is the only pest to be considered, applying the 2-lb. concentration to the trunks would be the most satisfactory of the treatments tested.

JOHANSEN (C.) & BREAKEY (E. P.). **Accumulated Residues of Insecticides tested to control the Orange Tortrix on Red Raspberries.**—*J. econ. Ent.* **42** no. 3 p. 543. Menasha, Wis., 1949.

The results are given of tests carried out in Washington in 1948 to measure the residues left on the fruit at harvest by sprays containing 2 lb. cryolite (90 per cent. sodium fluoaluminate), 2 lb. 50 per cent. wettable DDD (dichlordiphenyldichlorethane) and 0·3 lb. 25 per cent. wettable parathion per 100 U.S. gals. water, applied at 200 U.S. gals. per acre for the control of *Tortrix* (*Argyrotaenia*) *citrana*, Fern., on red raspberries. Insecticides had hitherto been applied only up to the blossoming period, for fear of toxic residues, but in these tests, in which the ripe raspberries used for analysis were picked on 9th July, three applications on 22nd April, 10th May and 4th June (the middle of the blossoming period) resulted in 0·6–0·7, 1–2·1 and 0·025 parts per million of cryolite, DDD and parathion, respectively, three on 10th May and 4th and 18th June resulted in 1·3–2, 4–6 and 0·019–0·035 p.p.m., and three on 4th and 10th June and 12th July, resulted in 5·4–7, 12–12·5 and 0·068–0·1 p.p.m. It was therefore concluded that applications, a fortnight before picking, of DDD, which has given the most consistently good insect control and the best residual action of the insecticides tested, could be recommended in 1949.

CHAMBERLIN (F. S.). **Experiments to control Aphids on Shade-grown Tobacco.**—*J. econ. Ent.* **42** no. 3 p. 544. Menasha, Wis., 1949.

Since Aphids, chiefly *Myzus persicae*, Sulz., have recently become injurious to shade-grown cigar-wrapper tobacco in Florida and Georgia, dusts were tested for their control in Florida in 1948. Tobacco plants were set out in the field on 26th March, and soon after they had become established, Aphid-infested seedling leaves were scattered throughout the field until heavy infestation was general. The population was allowed to increase until 19th April, when treatments were begun. Dusting was carried out at 7–9 a.m., when the air was generally calm and the foliage slightly damp with dew. Treatment with 1 per cent. parathion on 19th and 26th April, 10th and 24th May and 14th June kept populations extremely low throughout the growing period and gave complete protection to the plants, whether it was applied alone in pyrophyllite or a mixture of pyrophyllite and tobacco dust or combined with 5 per cent. chlordan, 10 per cent. DDT or both in the mixed diluent. None of these dusts appeared to injure the growing plants, and a single application remained effective for about two weeks. A 5 per cent. nicotine dust (prepared from nicotine-sulphate solution and a commercial dust containing 14 per cent. nicotine) applied on 19th, 26th and 30th April and 4th, 10th, 17th and 24th May reduced the population by about 48 per cent., but the survivors ruined the tobacco. Under the conditions of test, in which winged Aphids produced on untreated plants were a constant source of reinfestation during the greater part of the growing season, nine applications between 19th April and 14th June of a dust containing 1·5 per cent. essentially pure γ benzene hexachloride failed to give practical control ; there was an estimated loss of 75–85 per cent. of the tobacco and the large amounts of the dust applied left a disfiguring residue. Tobacco on untreated plots was completely spoilt by the middle of the growing season.

BYARS (L. F.). **The Mexican Leaf-cutting Ant in the United States.**—*J. econ. Ent.* **42** no. 3 p. 545, 4 refs. Menasha, Wis., 1949.

The author reports the discovery of a nest of *Atta mexicana*, F. Sm., in the Organ Pipe Cactus National Monument, near the Mexican border in southern

Arizona, in March 1946. Prominent plants in the vicinity are listed. This leaf-cutting ant is similar in appearance and presumably in habits to *A. texana*, Buckley, which occurs in north-eastern Mexico, Texas and western Louisiana. A key by which the major workers (soldiers) of the two species can be distinguished is given. Another colony of *A. mexicana* was found south of the border in Sonora among oak and mesquite (*Prosopis juliflora*) at an elevation of 3,350 ft. in December 1948, and *Citrus* damaged by this ant was observed at a height of 2,460 ft., although the species had not been reported previously at elevations above 2,000 ft. in north-western Mexico. These discoveries indicate that the species could survive in many parts of Arizona that have similar vegetation though at a lower altitude. A list is given of the localities in Mexico in which *A. mexicana* has been found.

DeBach (P.), Dietrick (E. J.) & Fleschner (C. A.). **A new Technique for evaluating the Efficiency of entomophagous Insects in the Field.**—*J. econ. Ent.* **42** no. 3 pp. 546–547, 2 figs., 6 refs. Menasha, Wis., 1949.

A description is given of a technique that has been used in California to evaluate the effectiveness of parasites and predators against *Aonidiella aurantii*, Mask., on *Citrus*, which is a combination of two already described [*R.A.E.*, A **31** 333 ; **36** 145]. Pairs of organdie sleeves, one of which has been impregnated with technical DDT, are put over branches on frames that keep them cylindrical. The ends of the untreated sleeve are left open to permit ingress and egress of parasites and predators. The treated sleeve is closed at both ends, and as the foliage does not touch the cloth and the scale is sessile on the foliage, neither the plant nor the host insect comes in contact with the DDT, whereas the active predators or parasites eventually touch it and are eliminated, with the result that the scale population increases as it would in nature if it had no natural enemies. Certain effects of the sleeves in altering the micro-climate can be minimised by putting the sleeves in proper positions with regard to the sun, and observations indicate that the natural enemies of *A. aurantii*, the citrus red mite [*Paratetranychus citri*, McG.] and the black scale [*Saissetia oleae*, Bern.] work as usual under these conditions. A comparison of results in the paired sleeves gives a direct evaluation of the effectiveness of the natural enemies, especially when the entire tree is used as a check against results in the open sleeve.

Sievers (A. F.), Archer (W. A.), Moore (R. H.) & McGovran (E. R.). **Insecticidal Tests of Plants from tropical America.**—*J. econ. Ent.* **42** no. 3 pp. 549–551, 2 refs. Menasha, Wis., 1949.

The following is virtually the authors' summary. Tests were made of the insecticidal properties of 78 species of plants used as fish poisons, insecticides or drugs, mainly in Venezuela, Colombia, the Guianas and Porto Rico. Seed and other propagating stock were collected in these regions and assembled for the cultivation of the species at Mayaguez, Porto Rico, to furnish material for the tests. Powders of the several plant parts of each species and extracts of such parts with organic solvents were tested. All the parts tested of *Mammea americana*, *Cnidoscolus urens*, *Gliricidia sepium*, *Hura crepitans* and *Piscidia piscipula* had insecticidal action against some of the 15 species of insects used in the tests. Since the toxicants were not identified, some of the toxic plants may contain new insecticidal constituents of possible commercial value. Lists are given of the 30 plants of other species that were toxic to some degree and of the 43 that were not.

Roussel (J. S.) & Gaines (J. C.). **Comparison of Calcium Arsenates alone and mixed with organic Insecticides for Cotton Insect Control.**—*J. econ. Ent.* **42** no. 3 pp. 551–552, 2 graphs, 9 refs. Menasha, Wis., 1949.

The results are given of tests in a dusting tower at College Station, Texas, to compare a special calcium arsenate, containing 33·2 per cent. total arsenic, 6·7 per cent. water-soluble arsenic and no free lime, with commercial calcium arsenate, containing 28·1 per cent. total arsenic, 0·14 per cent. water-soluble arsenic and 16·8 per cent. free lime, against *Anthonomus grandis*, Boh., and mixtures of BHC (benzene hexachloride) or parathion with the special calcium arsenate against *Aphis gossypii*, Glov. Previous work had shown that BHC is incompatible with some forms of calcium arsenate [*cf. R.A.E.*, A **37** 151, 195, 198, 338]. In the tests against the weevil, the median lethal dosages in lb. per acre were 5·07 for commercial calcium arsenate and 4·95 for the special calcium arsenate. In tests against the Aphid, in which fresh mixtures of the latter with 0·5 per cent. γ BHC or 0·1 per cent. parathion were applied to infested cotton leaves and these were kept at 85°F. and 70 per cent. relative humidity for 24 hours before mortality was estimated, the median lethal dosages in lb. per acre were 9·33 and 2·97, respectively.

Cotton (R. T.) & Frankenfeld (J. C.). **Silica Aerogel for protecting stored Seed or milled Cereal Products from Insects.**—*J. econ. Ent.* **42** no. 3 p. 553. Menasha, Wis., 1949.

Experiments carried out by the authors with a finely divided silica, known as silica aerogel, indicate that this material is more effective against insects attacking stored grain and milled cereal products than any other form of silica dust tested. The original source of the silica is sodium silicate. In the manufacture of the aerogel, the liquid phase of the gel form is removed without otherwise altering the structure, air replacing the liquid that was present when the gel was made. This process results in a dry light particle having the same volume as the original gel, but which, unlike ordinary silica gel, is not hygroscopic. The chemical and physical properties of the aerogel are described, and it is stated to consist of 89·5–91·5 per cent. SiO_2, 5–6 per cent. volatile components (water, alcohol and acetaldehyde), 2·5–3·5 per cent. sodium sulphate and 1 per cent. aluminium and ferric oxides. The average diameter of the particles is 3–5 microns.

When adults of *Tribolium confusum*, Duv., *Calandra* (*Sitophilus*) *oryzae*, L., or *C.*(*S.*) *granaria*, L., and larvae of *T. confusum* and *Ephestia kuehniella*, Zell., were caged with 50–500 gm. wheat or seed products treated with various concentrations of the dust, the minimum effective dosages by weight were 0·025 per cent. for seed wheat containing 12 per cent. moisture or feed in pellet form, 0·05 per cent. for seed wheat containing 14 per cent. moisture or powdered hand soap (60 per cent. maize meal), 0·5 per cent. for ground feed and 1 per cent. for bird food (a mixture of seeds and finely ground feed). One treatment should afford protection from insect damage for an indefinite period. Heavy treatments caused complete mortality of insects in 1–2 weeks, whereas marginal dosages required five to six weeks for complete kill.

Preliminary tests indicated that light applications of silica aerogel to the surface of wheat in farm storage bins may prevent infestation by incoming insects. Its use throughout the bulk of grain is not recommended, as grain so treated would be subject to discount ; although cleaning operations remove much of the excess dust, enough clings to the bran coat of wheat kernels to make its presence evident to the touch.

In feeding tests, a suspension of silica aerogel in water (100 gm. per litre) was administered to guineapigs at the rate of 2 ml. suspension per day on six days a week for two months without affecting growth or producing the pathological lesions that would be expected if the material were absorbed. The dust is highly irritating when breathed, and if products are treated with it, suitable respirators and proper ventilation should be provided. A statement by the manufacturers is quoted to the effect that no evidence of acute toxicity was shown after inhalation of the powder in concentrations as high as 60 mg. per cu. ft. air, which is much higher than found in any industrial application, and that clinical and X-ray studies of workers exposed to silica aerogel during manufacture for five years and preliminary animal experimentation showed no evidence of silicosis, silica aerogels being as a rule incapable of producing nodular fibrosis of a silicotic type.

HASTINGS (E.) & PEPPER (J. H.). **Field Tests with new Insecticides for Control of the Alfalfa Weevil.**—*J. econ. Ent.* **42** no. 3 pp. 554–555. Menasha, Wis., 1949.

Hypera variabilis, Hbst. (*postica*, Gylh.), which appears to have become established in Montana during the last few years, is now a major pest of lucerne in the south-central counties of the State, causing so much damage in some areas that the planting of lucerne has been abandoned. A series of tests involving treatment of infested plots to destroy the overwintered adults before oviposition had begun was carried out in 1948. A three-year-old planting of lucerne comparatively free from grass and weeds and about a quarter of a mile from any other lucerne was divided into plots that received single applications of sprays prepared from emulsion concentrates at rates to give 2 lb. technical DDT, chlordan or toxaphene per acre on 20th April, when the new growth of lucerne was 1–1½ inches high and the temperature was about 65°F. Adults of *H. variabilis* occurred in all parts of the field, and *H. nigrirostris*, F., *Sitona cylindricollis*, Fhs., *S. hispidulus*, F., *Otiorrhynchus* (*Brachyrrhinus*) *ovatus*, L., and *Ceuthorrhynchus punctiger*, Gylh., were also present. Cutting the lucerne crowns half an inch below the soil surface showed 63, 45 and 68 per cent. mortality of adult weevils after 24 hours, 50, 59 and 50 per cent. after 48 hours and 95, 100 and 92 per cent. after 14 days on plants sprayed with DDT, chlordan and toxaphene, respectively. No lucerne shoots and stems contained eggs on the day of application, but 54, 1·5, 1·1 and 1·7 per cent. contained them after 14 days and 42·1, 4, 0 and 9·6 per cent. after 24 days on untreated plants and those receiving toxaphene, chlordan and DDT, respectively. The numbers of eggs per puncture were 1–11 ; most punctures contained three or more eggs and many stems had 2–3 punctures per stem. Examination of the plots 24 days after treatment showed 72, 38, 4 and 21 weevils per 100 sweeps of the net on untreated plants and those treated with toxaphene, chlordan and DDT, and examination 39 days after, when the eggs were hatching, showed 191, 92, 26 and 56, respectively. At the time of the first cutting, the foliage on treated plots was a healthy green colour, whereas untreated plants showed the white colour usually associated with the feeding of large numbers of larvae of *H. variabilis*. A week after the first cutting, there was no new growth on untreated plots and that on plots treated with DDT and toxaphene was retarded, whereas there was no retardation in new growth or vigour on that treated with chlordan. It is concluded that a properly timed application of a chlordan spray will destroy the adults before appreciable oviposition has occurred, but that once egg deposition has progressed to any extent, the value of this type of control is greatly diminished.

Roney (J. N.). **Bermuda Grass Seed Insects in Arizona.**—*J. econ. Ent.* **42** no. 3 p. 555. Menasha, Wis., 1949.

About two million pounds of seed of Bermuda grass [*Cynodon dactylon*] is grown under irrigation each year in Yuma County, Arizona. For many years, lucerne and Bermuda grass were grown as companion crops, but since the war many growers have planted entire fields to Bermuda grass, harvesting crops of about 300–800 and 300–450 lb. seed per acre in June and November, respectively.

In November 1947, yields were very low, and an unidentified Aleurodid was present in large numbers, but apparently caused no damage. During the winter of 1947–48, several fields of Bermuda grass began to die, and the crowns and many nodes were observed to be heavily infested by *Odonaspis ruthae*, Kot., a Coccid that had been found on the grass in scattered localities in Mississippi and Texas, but had not caused serious damage there. In June 1948, plants in the boot stage were found to be infested with thrips identified as *Chirothrips mexicanus*, Cwfd., and *C. falsus*, Priesner, which are common but not injurious in California. They were feeding inside the shuck and on the young seeds in the milk or dough stage. Parathion was tested for the control of the thrips as the chaff was to be destroyed, and 1 and 2 per cent. dusts were applied at the rate of 15–18 lb. per acre on 12th August. Counts of the numbers of thrips per 100 heads on 11th, 17th, 20th and 23rd August showed 120, 24, 10 and 10 on plants treated with the 1 per cent. dust, 98, 5, 2 and 0 on those treated with the 2 per cent. dust, and 116, 119, 125 and 124 on untreated plants. Two weeks after applying the dusts control was evident to the eye. In consequence of these results, growers applied 60,000 lb. 2 per cent. parathion dust that year, and examination on 30th November showed that dusted fields gave yields of about 350–450 lb. seed per acre, whereas undusted ones gave only 30–50 lb. The fields with the low yields showed thrips round the borders on this date, but there were no thrips on treated areas.

Bynum (E. K.), Ingram (J. W.) & Charpentier (L. J.). **Control of Wireworms attacking Sugar Cane in Louisiana.**—*J. econ. Ent.* **42** no. 3 pp. 556–557. Menasha, Wis., 1949.

In areas along the Mississippi River near Edgard, Louisiana, wireworms of the genera *Melanotus*, *Conoderus* and probably *Aeolus* so deplete the stand of sugar-cane planted in the autumn as to cause heavy losses of the plant-cane crop and make it unprofitable to retain the fields as stubble cane. Sugar-cane is planted by laying the entire stalks of cane lengthwise in the bottom of the row furrows and ploughing the soil back over them, and when this is done at the usual time in the autumn, the wireworms gnaw the buds of the seed cane during the autumn and winter. During 1941, an experiment was begun to compare the effect of summer and autumn planting on this injury. Four varieties were planted between 1st and 15th August and between 20th September and 10th October, and the average numbers of plants per acre were 39,270, 19,470, 19,680 and 21,870 for cane planted in summer and 10,950, 8,730, 7,410 and 3,450 for cane planted in autumn at the usual rate of two lines of cane per row, and 44,550, 21,270, 25,110 and 23,310 for summer planting and 14,250, 11,460, 8,310 and 6,840 for autumn planting at the rate of three lines per row. All stalks were planted with the ends overlapping a few inches. Although in every variety at both dates of planting there was some increase in stand from planting three instead of two stalks of cane, the increase was insufficient to pay for the extra cost of planting in nearly all tests. Since the stand from summer planting at the usual rate was more than twice that from autumn planting, some summer planting was done on the same plantation the following year with favourable results. In a further test in 1944, on two light soils and

one mixed one, cane of two varieties planted between 1st and 10th August gave 7–22 times as many plants per acre as the same varieties planted on 20th September, and the stand of cane in the autumn-planted plots was so poor that the yield was far below that of a normal crop.

Labour shortage, weather conditions, and lack of time to remove a preceding maize crop often make it difficult to plant the cane during the most favourable period in the summer, and insecticides were therefore tested for the protection of late-planted cane in 1947–48. The seed cane was planted in two lines per row on 10th October, and dusts containing 1 per cent. chlordan, toxaphene or DDT or 0·2 per cent. γ BHC (benzene hexachloride) were applied on it at the rate of 400 lb. per acre, after which it was covered in the usual way. There were 49,000, 45,500, 41,300, 26,300 and 11,500 plants per acre in the following May after treatment with chlordan, toxaphene, BHC and DDT and after no treatment, respectively, and the corresponding yields of sugar were 8,015, 7,709, 7,375, 6,744 and 4,646 lb. per acre.

OSBURN (M. R.). **Parathion Dust for Control of the Pineapple Mealybug.**—*J. econ. Ent.* **42** no. 3 p. 557. Menasha, Wis., 1949.

Preliminary tests with parathion, applied to pineapple plants for the control of *Pseudococcus brevipes*, Ckll., which usually feeds at the bases of the leaves near the ground and on the roots below the soil surface, were carried out in two localities in Florida in 1948. A 1 per cent. dust was discharged down into the centre of each plant so that most of it would be deposited as near the mealybugs as possible, and treated and untreated plants were pulled up and examined for infestation at intervals. In one place, none of the plants treated on 22nd July with 0·35 oz. dust per plant was infested on 20th August, as compared with 93 per cent. of the untreated ones. In the other, 13 per cent. of plants treated on 1st September with 0·16 oz. dust per plant and 57 per cent. of untreated plants were infested on 28th September, and on 17th November, 19 per cent. of the plants that received this treatment only, 21 per cent. of some given a second treatment on 29th September at 0·24 oz. per plant and 94 per cent. of untreated plants were infested. All the mealybugs on treated plants were on the roots below ground level, whereas most of those on the untreated plants were just above ground level at the leaf bases, and it is probable that the parathion did not reach the insects on the roots. The insecticide did not injure the plants, and analyses of ripe fruits that had been dusted at the rate of 0·48 oz. per plant seven weeks before maturity showed that the whole fruit contained only 0·01 part parathion per million. None was found in the peeled fruit.

KULASH (W. M.). **Further Tests with Soil Insecticides to control Southern Corn Rootworm.**—*J. econ. Ent.* **42** no. 3 pp. 558–559, 1 ref. Menasha, Wis., 1949.

In further tests with organic insecticides to protect maize seed and seedlings from damage by larvae of *Diabrotica undecimpunctata* subsp. *howardi*, Barber (*duodecimpunctata*, auct.), carried out in North Carolina in 1948 [*cf. R.A.E.*, A **36** 148], furrows 4 ins. deep were run by hand, fertiliser was distributed into them and covered lightly with soil, and the insecticide dust was sifted over a strip extending 6 ins. on either side of the centre line of the furrow and mixed with the soil by means of a stick dragged along the furrow. The maize seed was then dropped by hand and covered with soil to a depth of 2 ins. This was done on 30th April or 4th May, and six counts made at intervals of three days from 15th or 18th May showed that the percentage of plants damaged, allowance being made for those that did not emerge, averaged 2·5 for 4 lb. chlordan per acre, 3 and 3·5 for technical BHC (benzene hexachloride) at rates giving 0·2

and 0·4 lb. γ isomer, respectively, 4·5 and 5 for 1 and 2 lb. parathion, 21 and 11·5 for 5 and 10 lb. methyl-DDT (ditolyltrichlorethane), 14 and 11·5 for 5 and 10 lb. DDT, 12 for 10 lb. of a by-product of the manufacture of purified γ BHC composed of α and β BHC, 16·5 for 10 lb. methoxy-DDT (methoxychlor), 19·5 for 10 lb. toxaphene and 29·4 for no treatment ; the least significant difference was 7·31.

The greatest number of damaged plants was recorded on 24th March for both planting dates. Statistical analysis showed that there was no difference in germination that could be ascribed to the action of any of the insecticides, and the roots and foliage of treated plants were not noticeably different from those of untreated plants. It appears that the use of soil insecticides in the furrow may be a practical means of controlling *D. u. howardi* attacking maize seedlings, but before it can be recommended for general use with any of the new insecticides, the effect of soil insecticides on the microbiology of the soil, the possibility of affecting the flavour of plants, and particularly root vegetables, planted in treated soil and the general effect of accumulation of insecticides in the soil must be evaluated.

Christ (E. G.) & Driggers (B. F.). **Strawberry Weevil Control with new organic Insecticides.**—*J. econ. Ent.* **42** no. 3 p. 559. Menasha, Wis., 1949.

Anthonomus signatus, Say, is particularly injurious in New Jersey to strawberries grown near woods, hedgerows or other cover supplying suitable hibernation quarters for the adults. A dust containing lead arsenate diluted with lime or sulphur (1 : 5) has been the standard insecticide used against it for several years, but has recently not given satisfactory control in the southern part of the State. In tests of several organic insecticides for the control of the weevil, dusts were applied at the rate of 40 lb. per acre per application on 29th April, when oviposition was first noted, and on 7th May, when the adults were at their peak of emergence and activity. Dusts containing 5 per cent. toxaphene, 5 per cent. chlordan, refined BHC (benzene hexachloride) to give 1 per cent. γ isomer, and lead arsenate with sulphur (1 : 5) reduced the percentage of buds destroyed from 38·6 to 19·1, 5·6, 2·5 and 19, respectively, and it is concluded that further tests with BHC and chlordan would be desirable.

Doutt (R. L.) & Hagen (K. S.). **Periodic Colonization of *Chrysopa californica* as a possible Control of Mealybugs.**—*J. econ. Ent.* **42** no. 3 pp. 560—561, 2 graphs, 2 refs. Menasha, Wis., 1949.

Preliminary field tests in California showed that in the absence of insecticidal sprays, *Chrysopa californica*, Coq., controlled a species of *Pseudococcus* of the so-called *maritimus* complex attacking pear [*cf. R.A.E.*, A **37** 352], and subsequent tests showed that although DDT sprays were injurious to the adults of *Chrysopa*, the larvae survived and matured after being sprayed with the concentration normally used on pear in California (1·5 lb. 50 per cent. wettable DDT powder per 100 U.S. gals.). Observations indicated that natural field oviposition by the females of the overwintered generation began at about the time of the first DDT spray, so that there was often a scarcity of *Chrysopa* eggs in sprayed orchards and the mealybug consequently increased. Attempts were therefore made to supply sprayed pear trees with *Chrysopa* eggs obtained by mass production [*cf.* **38** 16], and it was found that a total of 14,000 eggs per tree distributed on 23 occasions between January and October and 4,500 distributed on nine occasions between May and August significantly reduced mealybug populations, though 5,000 eggs distributed on six occasions between January and April did not. Graphic comparison of *Chrysopa* populations

resulting from egg colonisations with those arising from natural oviposition in sprayed trees suggested that colonisations made between April and June exerted most influence on the suppression of the mealybugs.

Although this technique shows promise as a possible method of mealybug control, further investigations are necessary to determine the proper timing and the minimum numbers required.

TURNER (N.). **Control of Aphids on Tobacco.**—*J. econ. Ent.* **42** no. 3 pp. 561–562, 3 refs. Menasha, Wis., 1949.

Aphids have been present in insignificant numbers on tobacco in Connecticut for many years, but a moderate infestation developed in 1946, and serious damage occurred in 1947. The reason for this sudden increase is not known, but it coincided with the large-scale application of DDT to potatoes and may have been due to a repellent effect of the compound. Preliminary control tests showed that dusts and sprays of chlordan, dusts of BHC (benzene hexachloride) and the standard aphicides were relatively ineffective, but that BHC sprays and parathion dusts gave good results. In 1948, an infested plant-bed was dusted on 10th June, and counts of 50 plants for the various treatments on 16th, 23rd and 30th June showed that the numbers infested were 0, 0 and 4 for 1 per cent. parathion, 4, 4 and 2 for 1·5 per cent. γ BHC and 10, 7 and 8 for 10 per cent. DDT, as compared with 50 on 16th June and 45 on 30th for no treatment, and 5 on 16th June for 10 per cent. chlorinated camphene [toxaphene], which was ineffective on the subsequent dates. Uninfested plants that were dusted with 10 per cent. DDT on 10th June showed only 4 per cent. infestation on 23rd June, when neighbouring untreated plants averaged 88 per cent. infested, indicating that DDT has considerable value as a repellent or preventive treatment against the Aphids.

In field tests, parathion sprays prepared from a 25 per cent. wettable powder and two 20 per cent. emulsion concentrates with di-2-ethylhexylphthalate and amylacetate as the respective solvents were applied by aeroplane at the rate of about 0·2 lb. parathion in 3·5 U.S. gals. water per acre to shade-grown tobacco on 7th July, when the plants were 2 ft. high. No Aphids were present but small infested tobacco plants in pots were put between the field plants just before spraying, removed three hours later and examined after 48 hours. No Aphids survived the application of the phthalate emulsion, but one of the four plants had a few living Aphids after treatment with the wettable powder. The amylacetate emulsion was much less effective, but its distribution from the aeroplane was observed to be faulty. A spray containing wettable BHC powder, similarly applied at the rate of 0·5 lb. γ BHC in 3·5 U.S. gals. water per acre on 14th July, gave 51–90 per cent. control on the potted plants. On 4th August, several small fields of sun-grown tobacco were treated with about 4 oz. parathion in 8 U.S. gals. water per acre, applied from the borders of the fields with a mist blower. The effective swathe was about 100 ft. In general, the control was excellent, and no living Aphids were found a week later except on two plants in the middle of a field too large to be covered by the blower and on a few on the margins that were too close to the nozzle.

JOHANSEN (C.) & BREAKEY (E. P.). **Insecticides tested against the Willamette Mite on Red Raspberries.**—*J. econ. Ent.* **42** no. 3 pp. 562–563, 1 ref. Menasha, Wis., 1949.

In the Puyallup Valley of Washington in 1948, *Tetranychus willamettei*, McG., was found on red raspberry in the second week of April and heavy infestations developed in a few scattered fields by 1st June and in many by the end of July. There is increasing evidence that heavy mite infestation late

in the season may stimulate autumn growth, causing severe " winter kill " of the tops of the canes, which is very noticeable in the following season, but the cool wet weather that prevailed in western Washington throughout the season of 1948 undoubtedly kept the mite from causing severe damage. *T. willamettei* appeared to be the only mite present ; two predators, *Stethorus picipes*, Csy., and *Orius insidiosus*, Say, were abundant in fields heavily infested by it.

Proprietary preparations of various acaricides were tested for control ; they included dusts and sprays of tetraethyl pyrophosphate, which was the most effective and was recommended to growers who had a mite problem at picking time, and sulphur dust and dusts and sprays containing the dicyclohexylamine salt of dinitro-o-cyclohexylphenol, which were also used by growers. Dusts gave consistently better results than sprays, and the dusting equipment could be drawn more easily between the raspberry rows late in the season when the mite population was increasing. It was found that the dusting machinery could be adapted for this purpose by directing the nozzles very low so that the dusts would billow up through the foliage.

Outstanding control with a dust of 0·5 per cent. tetraethyl pyrophosphate was obtained by a grower who applied it at 30 lb. per acre on 24th July in a field that had an infestation of 3,000 mites per 25 leaflets on 15th July. A count on 6th August showed only 3 mites per 25 leaflets. Many growers incorporated either the dinitro compound or sulphur in one or more of the sprays or dusts applied against *Tortrix* (*Argyrotaenia*) *citrana*, Fern., early in the season, and this helped to keep the mite population low at that time. The use of DDD (dichlordiphenyldichlorethane) against the Tortricid did not result in increased infestation by the mite [*cf.* *R.A.E.*, A **38** 25].

Considerable plant injury resulted from the use of the dinitro compound at excessive strengths in sprays and dusts, but this was eliminated by using a maximum of 4 oz. 20 per cent. spray powder per 100 U.S. gals. water. Sulphur dusts applied during hot weather scorched the foliage severely, but wettable sulphur in a spray caused no damage.

It is recommended that a dinitro compound should be used sparingly in the sprays and dusts applied against *Tortrix citrana*, and that tetraethyl pyrophosphate should be applied against late season infestation.

Spiller (D.) & Denne (R. W.). **The Larval Transfer Method of determining Toxicity of Timber Preservatives to *Anobium punctatum* De Geer.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 129–139, 2 figs., 9 refs. Wellington, N.Z., 1949.

The following is virtually the authors' summary. An attempt was made to assess toxicity of timber preservatives by transferring partly grown larvae of *Anobium punctatum*, Deg., to treated blocks [*cf.* *R.A.E.*, A **36** 414] and recording survival after 16 weeks. When it was found that larvae refused to ingest treated wood the method was modified to allow for decrease in weight as a result of starvation. This refinement gave results convertible to ordinary mortalities with fair accuracy. When results obtained by larval transfer methods and modifications were compared with those obtained by egg-laying techniques [*cf.* **38** 138], it was found that larval transfer methods over-estimated the amount of preservative required to give complete kill of larvae. It is concluded that larval transfer methods are unsuitable for the assessment of toxicity of timber preservatives. The techniques adopted throughout the work are described.

SPILLER (D.). **Toxicity of Wolman Tanalith to the Common House Borer,** *Anobium punctatum* **De Geer.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 140–142, 2 refs. Wellington, N.Z., 1949.

Wolman Tanalith (a proprietary mixture of 25 per cent. sodium fluoride, 25 per cent. disodium hydrogen arsenate, 37·5 per cent. sodium chromate and 12·5 per cent. dinitrophenol) is the only water-soluble preservative used in New Zealand for pressure impregnation of building timbers to prevent attack by insects, notably *Anobium punctatum*, Deg. The manufacturers recommend a minimum dry-salt retention of 0·35 lb. per cu. ft. wood (2·9 lb. per 100 super feet), but this is based on experience in other countries, and since preliminary work indicated that a dry-salt retention of 0·25 lb. per cu. ft. wood (2·08 lb. per 100 super feet) was ample to prevent infestation by *A. punctatum* in *Pinus radiata* [*cf. R.A.E.*, A **37** 282] and several pressure impregnation schedules that readily provide complete penetration of *P. radiata* are available, further tests were made of the amount of Tanalith required to prevent establishment of *A. punctatum*. The experiments were carried out with blocks cut from sapwood of *P. radiata* and *Podocarpus dacrydioides*, using a method already described [**38** 138]. Loadings equalling and exceeding 0·06 per cent. of the dry weight of the wood gave complete mortality of the larvae, but loadings of 0·042 per cent. and less were insufficient to prevent development ; intermediate loadings gave inconsistent results. A loading of 0·06 per cent. is equivalent to a net dry-salt retention of about 0·14 lb. per 100 super ft., and the dosage at present recommended should therefore be reduced. A retention of 0·8 lb. per 100 super ft., provided that the material is evenly distributed, is more than sufficient to allow for variations in the density of the wood and operation of the treating plant.

SPILLER (D.). **Toxicity of Pentachlorophenol to the Common House Borer** *Anobium punctatum* **De Geer. 1. Residual contact and ovicidal Action.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 142–153, 4 graphs, 13 refs. Wellington, N.Z., 1949.

Pentachlorphenol is widely used on a commercial scale in New Zealand as a general preservative for the prevention and control of fungous and insect attack in timber. As it had been shown to prevent oviposition by *Anobium punctatum*, Deg. [*R.A.E.*, A **36** 415], and successful control of this beetle has frequently been reported following its use as a surface spray, the possible contact effect of deposits was tested, and in preliminary experiments the adults were killed after contact for a few hours. The development of *A. punctatum* from egg to adult lasts at least three years, and since the cost of treatment would be prohibitive if it should be necessary to repeat it each year before the flight period, experiments were made to determine the permanence of the treatment. Small blocks of wood cut from boards of *Pinus radiata*, *Dacrydium cupressinum*, *Podocarpus dacrydioides*, and *P. spicatus* were placed in a large beaker from which the air was then evacuated almost completely, after which it was filled with a solution of pentachlorphenol and the vacuum released. Experiments showed that this technique gave almost complete penetration. After soaking for one hour, the blocks were allowed to dry and were later exposed to individual ovipositing females (each accompanied by a male). The pentachlorphenol was used at concentrations of 0·25–2·2 per cent. in highly volatile petroleum ether that left no residue likely to produce an insecticidal effect, without the addition of a plasticiser. No significant difference was found in the results obtained with the different kinds of wood, but the repellent and toxic effects of the pentachlorphenol increased significantly with its concentration. A few months after treatment, the numbers of eggs laid per female averaged 0·18 on blocks treated with 2·2 per cent. pentachlorphenol

and 8·2 on untreated blocks, and the percentages that hatched were 23·3 and 93·4, respectively. This control is estimated to be equivalent to a mortality of 99·4 per cent. potential eggs. The results obtained with the same blocks one year after treatment were somewhat anomalous, but in the following year, the numbers of eggs per female and the percentage hatch averaged 5·8 and 11·6, respectively, for 2·2 per cent. pentachlorphenol and 22 and 91·2 for no treatment, equivalent to a control of 96·7 per cent. The effectiveness of the pentachlorphenol is considered sufficiently lasting to justify its extensive use for the treatment of existing infestations of *A. punctatum*. A concentration of at least 5 per cent. is recommended for the flood-spraying technique used in houses, and this treatment should continue to control beetles emerging from the wood for 3–4 years.

SPILLER (D.). **An Investigation into Numbers of Eggs laid by Field collected *Anobium punctatum* De Geer.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 153–161, 6 figs., 5 refs. Wellington, N.Z., 1949.

The following is virtually the author's summary. Field-collected females of *Anobium punctatum*, Deg., show great variation in numbers of eggs laid. As many lay none or very few eggs, the frequency distribution of egg-laying is markedly skewed towards the lesser items. It was found that these skew distributions plot as straight lines when frequencies of the cumulative distribution are converted to percentages and then to probits and these plotted against the square roots of numbers of eggs laid. Thus distributions are root-normal. With single females, curves are always truncated, while with groups of females the degree of truncation decreases as group size increases until, when sufficiently large groups of females are used, distributions are truly root-normal. It is considered that skew distributions originate with methods of collecting and do not represent egg-laying in the field.

Females with extruded genitalia laid but few eggs. Size and activity were also correlated with number of eggs laid, small females and large active ones producing fewer eggs than large inactive females. Techniques for utilising females are discussed with reference to egg-laying distribution, and it is considered that the present method of using 15–25 females randomised as to both locality and date of collection is adequate. Two oviposition cages suited to work with *Anobium*, and the methods of using them, are described.

SPILLER (D.). **A Note on the Susceptibility of Heat treated Wood to Attack by the Common House Borer *Anobium punctatum* De Geer.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 162–163, 2 refs. Wellington, N.Z., 1949.

Investigations in New Zealand have shown that the equilibrium moisture content of the wood of *Podocarpus dacrydioides*, *Dacrydium cupressinum* and *Pinus radiata* is reduced by drastic heat treatment, and the effect of such treatment on the susceptibility of timber to attack by *Anobium punctatum*, Deg., was accordingly investigated. Inch-cube blocks cut from sap-wood boards of *Pinus* and *Podocarpus* were heated for 24 hours at temperatures of 105–150°C. [221–302°F.]; determinations of the equilibrium moisture content and the susceptibility to *A. punctatum*, the latter by a method already described [*R.A.E.*, A **38** 138], were made immediately for half of them, the rest being first saturated with water and allowed to dry. The equilibrium moisture content of the saturated blocks was higher by an average of 0·7 per cent. than that of the others, but there was no difference in the liability of the timber to attack. Preliminary tests showed that samples of *P. dacrydioides* that had been kiln-dried at approximately 80°C. [176°F.] were as susceptible to attack as air-dried samples.

SPILLER (D.). **Effect of Humidity on hatching of Eggs of the Common House Borer** *Anobium punctatum* **De Geer.**—*N.Z. J. Sci. Tech.* **30** (B) no. 3 pp. 163–165, 1 fig., 3 refs. Wellington, N.Z., 1949.

The effect of humidity on the hatching of eggs of *Anobium punctatum*, Deg., was studied in the course of investigations in New Zealand during 1942–44, some of the results of which have already been noticed [*R.A.E.*, A **34** 211]. Groups comprising 50 adults selected at random or three pairs were kept in cages provided with small blocks of wood for oviposition at a temperature of 22·5±0·5°C. [72·5±0·9°F.] and constant relative humidities varying from 15 to 90 per cent. and from 45 to 95 per cent., respectively. In both seasons, the total number of eggs at each humidity varied from 250 to 1,000, with averages of 300–350 at each experiment. There was no significant difference in the percentages that hatched at relative humidities of 65 per cent. or more, but hatching was impaired at humidities between 50 and 60 per cent., and did not occur at 45 per cent. or lower, though the embryos developed fully. These results were confirmed by accumulated data on hatching under controlled and room conditions. With large numbers of eggs, the percentage to hatch at normal humidity was always 80–94, with averages of 89–91.

MENZEL (R.). **Schildwanzen als Ursache des Steinigwerdens von Birnen.** [Pentatomids as a Cause of the Hardening of Pears.]—*Schweiz. Z. Obst- u. Weinb.* **55** no. 26 pp. 507–508, 2 figs., 1 ref. Wädenswil, 1946.

Mirids are known to cause hardening and deformity of pear fruits in Switzerland as a result of their feeding on them [*cf. R.A.E.*, A **10** 583], and Pentatomids were observed causing similar injury on an espalier pear in the district of Zürich in 1946. The bugs fed on the immature fruits, 1–2 on each, and all the fruits became deformed. The tree was close to a wild grape vine, in which the bugs sheltered and reproduced.

SCHNEIDER (F.). **Prüfung von Winterspritzmitteln gegen die San José-Schildlaus im Süd-Tirol.** [Tests against the San José Scale in the South Tyrol.]—*Schweiz. Z. Obst- u. Weinb.* **55** no. 26 pp. 511–526, 3 figs., 5 refs. Wädenswil, 1946.

In view of the imminent danger that *Quadraspidiotus perniciosus*, Comst., might spread to Switzerland and the desirability of knowing whether the proprietary insecticides available there would be effective against it if it did, it was arranged in the winter of 1945–46 to test these in infested areas in France and Italy. The author here describes the work done in 1946 in the infested area to the south of Bolzano, in the South Tyrol [*cf. R.A.E.*, A **35** 201], which was the basis for the subsequent eradication of the infestations discovered in Switzerland in the course of that year [*cf.* **37** 64].

The tests were carried out on heavily infested young apple trees or stocks, and the materials were applied with a brush to individual branches or parts of branches or trunks, or whole trees were treated. The treatments were applied in the second half of March, and living and dead scales were counted in early June, when the overwintered females had become adult, production of young was in full progress and untreated trees were completely covered with crawlers, and again in mid-August. The first count was to estimate the mortality of the overwintering scales, and the second to ascertain the effects of the treatments on the production and survival of their progeny. Owing to high and variable mortality on untreated trees, control percentages were calculated according to Abbott's formula [**13** 331].

The individual results given by the numerous materials tested are shown in tables. When those for materials of similar types were averaged, it was found in June that tar distillates of the normal and emulsified carbolineum types [*cf.* **35** 70] gave only 65 and 60 per cent. control at normal concentrations and not more than 92 when these were increased by half. Preparations of dinitro-o-cresol were no more effective, whether used alone or with tar distillates, DDT was not highly toxic, and benzene hexachloride and barium sulphide were useless. Lime-sulphurs varied considerably in toxicity, but the best brands gave 90–95 per cent. control at suitable strengths. A combination of one lime-sulphur at 15 per cent. and an emulsified carbolineum at 6 per cent. gave 99 per cent. control, as compared with 60 and 55 per cent., respectively, for the two components separately. By far the best results were obtained with winter oils, which gave 95 and 98 per cent. control at 3 and 4·5 per cent. alone, and 98 and 100 per cent. with 1 and 1·5 per cent. dinitro-o-cresol, respectively. The best single oils were Volck Winter, which gave complete control at 3 per cent. in all tests, and Paramaag Winter, which did so in four tests out of five.

The principal feature observed in August was the remarkable lasting effect of lime-sulphur. Individuals that had migrated to treated areas were killed, and no living females were found on areas treated with 30 per cent. concentrations. Workers in the United States have reported similar findings and also a reduction in the fecundity of the surviving females [*cf.* **32** 75, etc.], and observations in June had shown a high proportion of second-stage females with no eggs or embryos. No other material produced similar effects.

Since winter sprays of strong lime-sulphur do not generally give good control of Aphids and Psyllids in the South Tyrol and summer sprays of nicotine applied against these are thought locally to have some effect on *Quadraspidiotus*, a branch heavily infested with crawlers and young Coccids that had just formed their scales was sprayed on 10th June with 1 and 0·5 per cent. of a preparation of 20 per cent. nicotine. The crawlers were killed immediately, but observations in August showed that mortality of individuals protected by their scales was unsatisfactory.

In a discussion of these results, it is pointed out that only highly effective materials are of any value against *Quadraspidiotus* because of its high reproductive potential. Concentrated lime-sulphur is expensive and could probably be used only in exceptional cases, so that chief reliance would have to be placed on winter oils. Treatment with oil in November–February followed by lime-sulphur immediately before bud-burst would be worth testing for complete eradication, and a combination of oil and dinitro-o-cresol would probably be the most satisfactory in areas in which sprays had to be applied regularly against the Coccid, since it would also control other pests, such as Aphids and Psyllids, that are resistant to oil alone.

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CONTENTS.

	PAGE
AFRICA, EAST : Sudden-death of Cloves in Zanzibar	229
AMERICA, TROPICAL : Tests of Plants as possible Sources of Insecticides	253
AUSTRALIA, SOUTH : An Outbreak of *Gryllulus servillei*	222
AUSTRALIA, SOUTH : Fluctuations in Population of *Thrips imaginis* ...	228
BRITAIN : The Arthropod Population of Pasture Soil	228
BRITAIN : Overwintering of Aphids in Mangel Clamps	230
CHANNEL ISLANDS : *Leptinotarsa decemlineata* in 1947 and 1948	231
FINLAND : Studies on *Meigenia mutabilis*	223
GERMANY : Crop Pests and Diseases and their Control (*Review*)	224
GERMANY : The Spread and Control of *Quadraspidiotus perniciosus* ...	224
GERMANY : The Problem of the second Generation of *Cydia pomonella* ...	225
ITALY : Tests of Winter Sprays against *Quadraspidiotus perniciosus* ...	263
MEXICO : Cotton Insect Control with DDT and BHC	241
NEW ZEALAND : Tests of the Toxicity of Timber Preservatives to *Anobium punctatum*	260, 261
NEW ZEALAND : Numbers of Eggs laid by field-collected *Anobium punctatum*	262
NEW ZEALAND : The Susceptibility to *Anobium punctatum* of heat-treated Wood	262
NEW ZEALAND : The Effect of Humidity on Eggs of *Anobium punctatum*	263
SWEDEN : Differences between *Psylla mali*, *P. peregrina* and *P. sorbi* ...	223
SWITZERLAND : Deformity of Pear Fruits caused by Pentatomids ...	263
U.S.A. : Particle Size and Toxicity of HETP Aerosols	221
U.S.A. : Effect of Temperature and Humidity on Insecticides against *Anthonomus grandis*	235

CONTENTS—*cont.*

PAGE

U.S.A. : Resistance to *Attagenus* of Cloth treated with Insecticides ... 236
U.S.A. : Size of Screens for Jars of Bait for *Cydia molesta* 236
U.S.A. : Insecticides for protecting Maize Ears from *Heliothis armigera* 237
U.S.A. : Studies on Hibernation and Food-plants of *Epilachna varivestis* in California 237
U.S.A. : Investigations on *Dendroctonus frontalis* in Florida 238
U.S.A. : Effects of DDT and Chlordan on Pests and Yield of Potatoes ... 239
U.S.A. : Effects of Temperature and Humidity on Females of *Pyrausta nubilalis* 240
U.S.A. : Insecticides against *Colias eurytheme* on Lucerne in California ... 242
U.S.A. : The Effect of Insect Control on Seed Production of Lucerne ... 242
U.S.A. : A new Insecticide for Control of Insects in Turf 243
U.S.A. : The Control and Natural Enemies of *Laphygma frugiperda* in Virginia 245
U.S.A. : Field Experiments for Control of *Polychrosis viteana* 246
U.S.A. : Chlordan and BHC against *Conotrachelus nenuphar* on Peach ... 247
U.S.A. : The Effect of DDT Dust on *Nomia melanderi* 247
U.S.A. : Automatic Traps for killing Adults of *Popillia japonica* ... 249
U.S.A. : The Establishment of *Agathis diversa* as a Parasite of *Cydia molesta* 250
U.S.A. : *Pseudocneorrhinus bifasciatus* in New Jersey 250
U.S.A. : Termite Treatment with Chlordan 250
U.S.A. : Parathion against *Wasmannia auropunctata* on *Citrus* 251
U.S.A. : Insecticide Residues on Raspberries sprayed against *Tortrix citrana* 252
U.S.A. : Dusts against Aphids on Tobacco in Florida 252
U.S.A. : *Atta mexicana* in Arizona 252
U.S.A. : A Technique for evaluating Efficiency of entomophagous Insects 253
U.S.A. : Comparison of Calcium Arsenates for Cotton Insect Control ... 254
U.S.A. : Sprays against *Hypera variabilis* on Lucerne in Montana ... 255
U.S.A. : Bermuda Grass Seed Insects in Arizona 256
U.S.A. : Control of Wireworms attacking Sugar-cane in Louisiana ... 256
U.S.A. : Parathion Dust against *Pseudococcus brevipes* on Pineapple ... 257
U.S.A. : Soil Insecticides against *Diabrotica undecimpunctata howardi* on Maize 257
U.S.A. : Organic Insecticides against *Anthonomus signatus* on Strawberry 258
U.S.A. : The Use of a Chrysopid against Pear Mealybugs in California ... 258
U.S.A. : Control of Aphids on Tobacco in Connecticut 259
U.S.A. : Acaricides against *Tetranychus willamettei* on Raspberries in Washington 259
The Advantages and Disadvantages of Arsenicals as Insecticides ... 225
Some Results of physiological Evaluation of DDT and BHC 226
The Larvae and Pupae of Diptera (*Review*) 227
Locust Migrations and Meteorology in the Gulf of Aden Area 227
The Spatial Distribution of Insect-borne Plant-virus Diseases 230
Relation between Particle Size and Toxicity of Insecticide Suspensions ... 232
Loci of Action of DDT in *Periplaneta americana* 233
The Effect of DDT on Acetylcholine, etc., in Insects 233
Experiments with DDT and Cholinesterase of Serum 234
Asorption and Translocation of Parathion in Plants 234
Temperature and Moisture affecting Persistence of Toxicity of DDT ... 235
Fumigant Properties of several new Insecticides 236
The Toxicity of various Insecticides to Bees 248
Silica Aerogel for protecting Stored Cereals from Insects 254
A Catalogue of the Parasites of Insect Pests (*Title only*) 264
Synthetic Compounds of the Pyrethrin Type (*Title only*) 264

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